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THE
TWENTY-FOURTH
ANNUAL REPORT
OF THE
MARYLAND
AGRICULTURAL EXPERIMENT STATION.

COLLEGE PARK,
PRINCE GEORGE COUNTY, MARYLAND

1910—1911

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The Maryland Agricultural Experiment Station.

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The Board of Trustees of the Maryland Agricultural College

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STATION OFFICERS AND STAFF.

HARRY J. PATTERSON, B. S.	*Director and Chemist.*
SAMUEL S. BUCKLEY, M. S., D. V. S.	*Animal Pathologist.*
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W. R. BALLARD, B. S.	*Assistant Horticulturist.*
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R. S. ALLEN	*Assistant Dairyman.*
L. B. KIMBLE	*Stenographer.*
ROY C. TOWLES	*Clerk.*
H. FORD	*Treasurer.*

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*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Hyattsville Exchange.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Md.

LETTER OF TRANSMITTAL.

To His Excellency, Austin L. Crothers,

Governor, and President of the Board of Trustees,

Annapolis, Maryland.

Sir:—In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the Honor to transmit the Twenty-fourth Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1911.

Very respectfully yours,

H. J. PATTERSON,

July, 1911.

Director of the Experiment Station.

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THE MARYLAND AGRICULTURAL
EXPERIMENT STATION

Vol. 24. 1910-1911.

TWENTY-FOURTH ANNUAL REPORT OF THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

For the Year Ending June 30, 1911.

By H. J. PATTERSON, Director.

To the Board of Trustees of the
Maryland Agricultural Experirment Station.

Gentlemen: In accordance with the usual custom I hand you herewith a report upon the work and expenditures of the Experiment Station for the past year with outlines and recommendations for the coming year.

GENERAL CONDITION.

The general interest in the Experiment Station and its work has shown a steady growth during the year and the demand for help along some lines has been greater than our facilities would enable us to give.

The demand for work of an extension and demonstration character is particularly great and would warrant, if funds were available, the organizing of the staff so as to have some men primarily for this purpose. Such an organization would not only make it possible to take the results of the Station work to the people but it would cause less interruption of the time of the investigators and enable them to accomplish more.

The general condition of the Station work is quite satisfactory.

ORGANIZATION AND DIVISION OF WORK.

The following outline will give a general idea of the work of the different members of the Station Staff:

Soils	Invesitgations with fertilizers, lime and fertility studies.		H. J. Patterson. L. B. Broughton. E. H. Brinkley.
Crops	Cereals, hay, forage and green manure crops.		N. Schmitz.
	Horticultural crops.		C. P. Close. Thos. H. White. Walter R. Ballard.
	Botany and Plant Pathology.		J. B. S. Norton.
	Physiology and Plant Chemistry.		C. O. Appleman.
	Tobacco Investigations. (In cooperation with U. S. Dept. Agr.)		W. W. Garner. D. E. Brown.
	Entomology.		T. B. Symons. A. B. Gahan. E. N. Cory.
Animals	Poultry	Diseases.	G. E. Gage.
		Commercial Problems.	Roy H. Waite.
	Pathological Milk Studies and City Milk Supply.		S. S. Buckley.
	Dairy Field Work, Cow Testing, Breeding Associations, etc. (In cooperation with U. S. Dept. Agr.)		G. H. Hibberd.
	Feeding experiments with cows, calves, hogs.		H. J. Patterson. R. S. Allen.

INVESTIGATIONS IN PROGRESS.

Most investigations must be carried through a number of years in order to get reliable results, hence new investigations can only be taken up as others are completed or as more funds become available. As the Station's income has been constant for several years there has been practically nothing for expansion.

The details of the work in progress was given in the report of last year, (see Twenty-third Annual Report), and in this report only such details will be given as will supplement or indicate the changes made since last year.

Beside the investigations pursued there is much routine work, such as answering inquiries, identifying specimens, analyzing samples, etc., done by almost every department.

SOIL AND FERTILITY INVESTIGATIONS.

The laboratory study on the diffusion and depletion of lime in soil is nearly completed and as soon as the results are compiled it is proposed to take up a study of the exact chemical and physical effects of lime on soils. I recommend that a study be made of the chemical and physical properties of some productive and unproductive soils of different kinds and types, and also a study of the effects of brackish waters on crops. so as to determine their availability for irrigation purposes.

CEREAL AND FORAGE CROP INVESTIGATIONS.

This is an important class of crops in Maryland, as it represents two-thirds of the value of the farm products of the State and the full development of the live stock and dairy interest is dependent upon the growing of grain and forage. A detailed list of the tests under way was given in the Twenty-Third Annual Report (see report).

The following additions have been made during the year:

Some of the wheat, oats and barley test had reached a stage where it was desirable to have them grown in different sections of the State. Accordingly, last fall there was sent from one to four varieties of wheat to 30 farmers; one to three varieties of winter oats to 10 farmers and one variety of winter barley to several farmers. Each farmer was given at least enough of each variety for one acre so as to make it worth while for them to go to the extra expense and trouble to keep them separate and also give them enough to have a start for commercial purposes should the variety have special merit.

In Garrett County alfalfa was started at two points so as to determine whether it could be grown in that part of the State and made a crop of interest to dairymen and stock raisers.

HORTICULTURAL INVESTIGATIONS.

The great interest in the growing of orchard fruits and almost phenomenal development of this industry in the western and northern part of the State has made an unusual demand upon this department for help for pruning and spraying demonstrations, and for examining orchard sites. This work has curtailed the investigations to some extent.

Some changes have been made in the fruit plantations: The old blackberry patch was discarded because of age and the "double-blossom disease" and a new planting was made. The apple orchard south of the main college building was removed because it was poorly located and the varieties were of little value to this section or duplicates of those in the other Station orchards. This land will be used for vegetable work. The old vineyard is practically worthless and will be discarded at the end of this season. A new vineyard has been started and it will be used for a series of pruning tests.

An overhead or sprinkling system of irrigation was installed to irrigate a strip of land 40′ x 300′. Various vegetables will be used in this test.

The test of the use of orchard heaters for protection against late frosts has been extended so as to include two points in Western Maryland, one on the Eastern Shore and one in the Experiment Station orchard. A test is also being made of these heaters for protecting strawberry beds.

TOBACCO INVESTIGATIONS.

The tobacco investigations are being conducted in cooperation with the U. S. Department of Agriculture as in the past. Dr. W. W. Garner, Chief of the tobacco investigations, will supervise the work in Maryland instead of E. H. Mathewson who has been moved to North Carolina. The work outlined last year has been continued, and the following new lines have been inaugurated this season:—

1. Tobacco and crimson clover and vetch cover crops continuously with and without fertilizer, (3 plots of ¼ acre each).
2. Tobacco in 2 year rotation with winter oats and cowpeas with and without fertilizer, (4 plots of ¼ acre each).
3. Tobacco and late potatoes in 2 year rotation with winter oats and crimson clover, (4 plots of ¼ acre each).
4. Tobacco and early potatoes in 3 year rotation with wheat and red clover, (6 plots of ¼ acre each).

BOTANICAL AND PATHOLOGICAL INVESTIGATIONS.

Professor Norton contiues to devote five-sixths of his time to investigation work under the plan outlined last year.

There has been a large number of plants sent in for identification and many samples of seed for determination of their purity. A bulletin will be prepared during the summer giving the results of the seed examinations. A bulletin has been prepared covering all phases of the weed question, which will include the results of tests on the eradication which has been made during the past 9 or 10 years.

There has been considerable time given to the study of tomato variations in conjunction with the work being conducted in the horticultural department.

The investigations of the leaf mould fungus and the leaf spot fungus of the tomato has been given much time during the past year and will be a prominent part of the work for the coming year.

PLANT PHYSIOLOGICAL INVESTIGATIONS.

The laboratory for this class of investigation was started last September. Considerable time was required to get the laboratory equipped and in condition for work.

The lines of work undertaken the past season have been a study of the "little sprout disease" of the potato and some chemical and enzyme studies of the "peach yellows." These two lines of work will be continued during the coming year and in addition a study will be made of the "after ripening" process in potato tubers with a view of determining the limiting factors of growth during the rest period and thus suggest some means for the artificial control of the rest period of tubers and bulbs.

This department will also assist in some phases of botanical studies.

INVESTIGATIONS IN ENTOMOLOGY.

The work of this department has been continued along th same lines as given in the last year's report. Each year brings some insect to special notice as being particularly numerous and harmful which calls for special effort and labor in a direction which had not been anticipated.

The special spraying demonstrations conducted by this department for the control of scale and codling moth has been productive of much good and created a greater demand for this class of work than the present force is able to do. There are many ways in which this department could be expanded and meet popular demands for help if more funds were available. There have been four bulletins issued from this department during the past year.

POULTRY INVESTIGATIONS.

Biological Studies.

During the past year the equipment for the poultry disease work has been enlarged by adding a wing 18 x 24 to the building. This provided a small office, hospital and dissecting room with a large incubator room in the basement.

This addition also permitted the re-arranging of the other part of the building so as to make it more convenient. There has also been constructed some poultry houses and yards for the special use of the disease studies.

The study of the bacteria and animal organisms in the intestinal contents and mucosa of healthy chickens has been completed and a report is in press giving the results. There is now in progress a study of the "White Diarrhoea" of chickens and the possibilities of the prevention of the disease by subcutaneous and intravenous injections of some phenol compounds into fowls whose ovaries are infected.

COMMERCIAL STUDIES.

The work outlined in the last report has been pursued, and the following new lines conducted during the past year:

1. Test of simplified feeding mixtures composed of grains produced on the farm.
2. Comparison of rations composed of corn and wheat products on the quality and quantity of the eggs.
3. Length of time required for eggs to become fertile after the male is placed with hens and the length of time eggs will remain fertile after the male is removed.
4. Effects of age of eggs on incubation.

The poultry department cooperated with the college in giving the 10 day special poultry course. Exhibits were made from this department the past year at Taneytown Exhibition, the Baltimore Poultry Show and the National Corn Exposition. Preparations are being made to use this exhibit at the various county fairs in Maryland this summer.

DAIRY INVESTIGATIONS.

The chemical and physical studies on milk as it relates to its food value are being continued, as well as the other subjects outlined in the last report.

Recently we have been able to form a plan for cooperation in some dairy field work with the U. S. Dairy Division. They have placed Mr. G. H. Hibberd in Maryland, with headquarters at the Station. He is to work under our general direction on problems which will develop and aim to make dairying in Maryland more profitable.

The principal line of work at present is the forming of cow testing associations, cooperating with farmers in herd testing, the forming of dairy breeding associations and the devising of means to encourage the creameries to make a better and more uniform product. The work of the cow testing association of Baltimore County seems to have been well received, and if the lesson learned is followed up should aid materially in getting a better average profit from the cows in the herds of the members of the association. There are prospects of some breeding associations being formed, and I would recommend that we give such help to the project as will encourage the work and put it on a good substantial basis, and give us the benefit of the records and results.

The results of keeping cows in the open barn has continued to be very satisfactory. The cows seem to be comfortable, and make as good yields as those in the closed barn. The cost of food for producing 100 lbs. of milk in the open barn has been very little more than in the closed barn, while the cost of labor has been less.

SWINE INVESTIGATIONS.

The work outlined in the last report has been partially completed, and reported upon in a bulletin. The other parts are still under way.

Some work in forage crops for hogs should be done, but we do not have the facilities for doing it here in connection with the other investigations. I would recommend that if satisfactory arrangements can be made, and funds will permit, that some of this work be performed in cooperation with farmers in the State.

SHEEP INVESTIGATIONS.

There is no doubt that the opportunities for the sheep industry in Maryland is not fully realized, and certainly but little developed. The revenues to the State from the proper development of this industry and the utilization of the lands that are now idle, and which could pasture sheep, should be at least five million dollars more than at present.

I would recommend that the Station take up some work which would form the nucleus for such a development as soon as funds are available and satisfactory arrangements can be made.

HORSE INVESTIGATIONS.

There is a considerable number of horses raised in Maryland, but many of them are not of the character or quality to meet the demands of our markets, or bring the most profit. I would suggest that a survey be made of the horse industry of the State, with the idea of placing some reliable data and definite examples of conditions before our people, in hopes that such information would be a stiumlus to improvement.

DEMONSTRATION TESTS.

There are many farmers that are slow to adopt the results of tests particularly if they have been obtained at some distance from them. Then again there are many matters that need to be tested in a larger way and under more normal commercial conditions than is possible on the Station farm. To overcome these difficulties the Station has done considerable in the way of cooperating with the farmers in different parts of the State in making demonstration tests. One of the difficulties in conducting such work is to give them proper supervision, as the time of the Station men and the expense involved would not permit many visits. Last March the Baltimore County School Board proposed to us a plan of cooperation whereby they would share the cost of supervision, and have this work done by the Principal of their Agricultural High School. As the funds were available this offer was accepted, as it enabled us to meet the demand from the farmers of that county for tests of this nature, and then, too, it offered an opportunity to inaugurate the plan of making the county Agricultural High Schools the local agents of the Experiment Station for cooperative work and the center for collecting and distributing information for a given county or neighborhood. If this plan is successful in that county it will probably result in work of similar nature in other counties, and the ultimate financing and development of such work on a systematic plan which would enable the results of Station work to be carried into every neighborhood in a way that would cause their general application almost immediately. I would recommend the continuance of this work for at least another year.

At present the work is being conducted on about 100 different farms of Baltimore County, and covers the following subjects:

1. Variety tests of corn.
2. Variety tests of potatoes.
3. Breeding plots of corn.
4. Tests of top-dressing wheat and timothy with nitrate of soda.
5. Comparison of raw and dissolved phosphate rock.
6. Comparison of burned and unburned lime.
7. Test of supplementing of stable manure with phosphoric acid and potash.
8. Improvement of wheat by head selection.
9. Crimson clover as a cover crop.
10. Tests of method of seeding timothy and clover.
11. Test of low and high head trees, one and two years old.
12. Variety tests of small fruits and orchard fruits on the High School grounds.

A test of some fertilizers and varieties of corn is also being made at the Montgomery County Agricultural High School.

The Station is cooperating with the authorities in ten counties in conducting corn-growing contests.

Demonstrations of Clearing Land.

Demonstrations were conducted during the past year on the Experiment Station farm of the use of dynamite for clearing land of stumps, digging ditches and digging holes for setting trees. Stumps were removed from about 8 acres, and land which was nearly worthless in its previous condition. This land was gotten ready for crops in 10 months' time. The cost of the entire work of draining, clearing, etc., was about $65 or $70 per acre, which was entirely paid for by the lumber and wood gotten from the land.

EXHIBITS.

I recommend that exhibits of the Station work be made at the county fairs as usual this season, alternating them so that a different subject is presented at each fair each season.

PUBLICATIONS.

During the year the following publications have been issued:

July, 1910, The Twenty-Third Annual Report.

July, 1910, Bulletin 146, Poultry House Construction and Its Influence on Domestic Fowls. By C. L. Opperman.

August, 1910, Bulletin 147, Wheat—Variety Tests, Smut and Scab. By N. Schmitz.

November, 1910, Bulletin 148, The Control of the San Jose Scale. By T. B. Symons.

December, 1910, Bulletin 149, The Terrapin Scale. By T. B. Symons and E. N. Cory.

January, 1911, Bulletin 150, Hog Feeding and Hog Houses. By A. L. Stabler.

February, 1911, Bulletin 151, Fertilizer on Asparagus. By C. P. Close.

March, 1911, Bulletin 152, Aphidiinæ of North America. By A. B. Gahan.

May, 1911, Bulletin 153, The Bacteria Flora in the Intestinal Contents of Healthy Chickens. By G. E. Gage.

June, 1911, Bulletin 154, Bee Keeping. By T. B. Symons and A. C. McCray.

The demand for our bulletins has been very great the past year, which is the result of the favorable press comments, and also evidence that they give the information which people are seeking.

STATION STAFF.

During the year the following changes have taken place in the Station staff:

Mr. A. L. Stabler resigned to accept a position at the Baltimore County High School to assist in the teaching and the supervision of the cooperative demonstration tests.

Mr. T. R. Stanton resigned April 15th to accept a similar position to the one he held here with the United States Department of Agriculture. Mr. R. C. Towles, of Prince George's County, was appointed to fill the vacancy in the clerical force.

I recommend that I be allowed to fill the vacancy caused by the resignations indicated above whenever the work on hand makes more help necessary.

STATION FELLOWSHIP OR SCIENTIFIC AIDS.

I recommend that the Station employ young graduates who desire to pursue scientific work and studies for some of the special investigations which different departments have planned, and which cannot be done with the present force, and which can be carried out with help of this nature. The idea is that not more than one such assistant be employed in any one department, and that not more than four employed at any one time at a cost not to exceed $300 per year each, and that the expense be charged to the labor fund. This plan would give some of the departments an opportunity to complete more promptly many lines of work that are often on hand for years, and it would also serve as a training ground for men for other positions.

NEEDS OF THE STATION.

The Station could profitably use much more money in its work, and must have more if it is to meet all of the demands made upon us. We particularly need more for demonstration tests and for printing bulletins, etc. The Station needs better facilities for housing its tools, so as to be able to get at them with ease, either for use or demonstration. A proper building should be so planned and equipped as to make it available for firms desiring to do so, to exhibit and demonstrate new implements to both students and farmers.

FINANCES.

The work the past year has been conducted along the lines adopted and within the appropriation made for this fiscal year. The following reports of the Treasurer gives the details of the expenditures for the past year.

Maryland Agricultural Experiment Station in Account with the United States Appropriations, 1910-1911.

Dr.	HATCH FUND	ADAMS FUND
To Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1911, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00
Cr.		
By Salaries	11,290.09	11,354.30
By Labor	2,243.93	182.67
By Publications	366.18	(Omit)
By Postage and Stationery		2.33
By Freight and Express		2.36
By Heat, Light, Water, and Power		149.07
By Chemicals and Laboratory Supplies		537.94
By Seeds, Plants, and Sundry Supplies.	38.99	103.43
By Fertilizers		
By Feeding Stuffs	688.93	870.00
By Library		267.49
By Tools, Machinery, and Appliances	65.93	61.87
By Furniture and Fixtures		233.29
By Scientific Apparatus and Specimens		128.78
By Live Stock	300.00	340.00
By Traveling Expenses	5.95	29.31
By Contingent Expenses		
By Buildings and Land		737.16
Balance		
Total	$15,000.00	$15,000.00

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

STATE FUND.

Maryland Agricultural Experiment Station, in Account with the State of Maryland Appropriation.

DR.

1910.		
July 1—	To cash balance	$9 81
	From State	10,000 00
	Interest	21 30
		$10,031 11

CR.

1911.			
June 30—	By repairs	$ 418 28	
	Publications	1,646 05	
	Exhibits	241 11	
	Freight and Express	432 59	
	Feeding Experiment	1,255 35	
	Poultry Experiment	173 02	
	Tobacco Experiment	910 24	
	Insurance	333 34	
	Labor	528 53	
	Seed Plants and Sundries	1,140 18	
	Tools, Implements and Machinery	457 05	
	Chemical Supplies	63 40	
	Travel	432 42	
	Salaries	575 00	
	Postage and Stationery	136 40	
	Irrigation and Drainage	225 42	
	Furniture and Fixtures	25 35	
	Library	234 69	
	Fertilizer	624 36	
	Light, heat and water	133 34	
	Balance	44 99	
	Total		$10,031 11

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

HORTICULTURAL FUND.

The Maryland Agricultural Experiment Station, in Account with the State of Maryland Appropriation for Horticultural Investigation.

DR.

1910.	
July 1—To Cash Balance	$27 22
Interest	21 92
State	4,000 00
	$4,049 14

CR.

Salaries	$ 176 50	
Seed Plants, Sundry Supplies	647 48	
Travel	438 41	
Library	48 14	
Labor	1,307 67	
Fertilizer	92 47	
Postage and Stationery	109 16	
Tools, Implements and Machinery	421 49	
Heat, Light and Water	52 37	
Publications	199 47	
Freight and Express	30 35	
Scientific Appropriation	51 96	
Furniture and Fixtures	67 25	
Balance	406 42	
Total		$4,049 14

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

STATION FARM FUND.

Maryland Agricultural Experiment Station, in Account with the Station Farm.

DR.

1910.		
July 1—To Balance		$392 94
Sale of Stock, Produce and Labor		7,871 42
		$8,264 36

CR.

Live Stock	$587 00	
Tools, Implements and Machinery	87 57	
Feed Stuff	162 42	
Travel	69 08	
Freight and Express	562 09	
Seed Plant and Sundry Supplies	397 00	
Labor	4,755 56	
Building and Repairs	41 01	
Salaries	542 54	
Exhibits	320 63	
Postage and Stationery	76 62	
Drainage	192 25	
Balance	467 59	
Total		$8,264 36

The above is a true copy from the books of the office.

HERSCHEL FORD, *Treasurer.*

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 146. JULY, 1910.

POULTRY HOUSE CONSTRUCTION AND ITS INFLUENCE ON THE THE DOMESTIC FOWL.

PART I.

By C. L. Opperman.

INTRODUCTION.

The housing of poultry has, for many years, been a subject of widespread interest and study throughout the entire country, and has resulted in bringing about a marked improvement in poultry house construction. Aside from popular articles, however, there is very little experimental data or literature which will furnish information relative to the effect of certain housing conditions on the domestic fowl. There is much need for some definite economic information on this subject. It certainly is not a good commercial proposition to invest five dollars per fowl in houses alone, if seventy-five cents will do just as well.

PURPOSE OF THE EXPERIMENT.

The importance of the question has led this Station to conduct a series of investigations relative to the influence of certain types of houses, on the following questions:

(1) The influence on environment.
(2) The influence on the cost of construction.
(3) The influence on the health of the adult fowl.
(4) The influence on the cost of feeding.
(5) The influence on egg production.
(6) The influence on the vitality of the developing embryo.
(7) The influence on the progeny to eight weeks of age.
(8) The influence on future generations.

The ultimate object of the work is to determine, if possible, the type of house which is best adapted to the climate of Maryland.

The investigations were started in November, 1907, and this bulletin gives the results of the first and second year's work. It should be considered only as a preliminary report, as it does not deal with the influence on future generations.

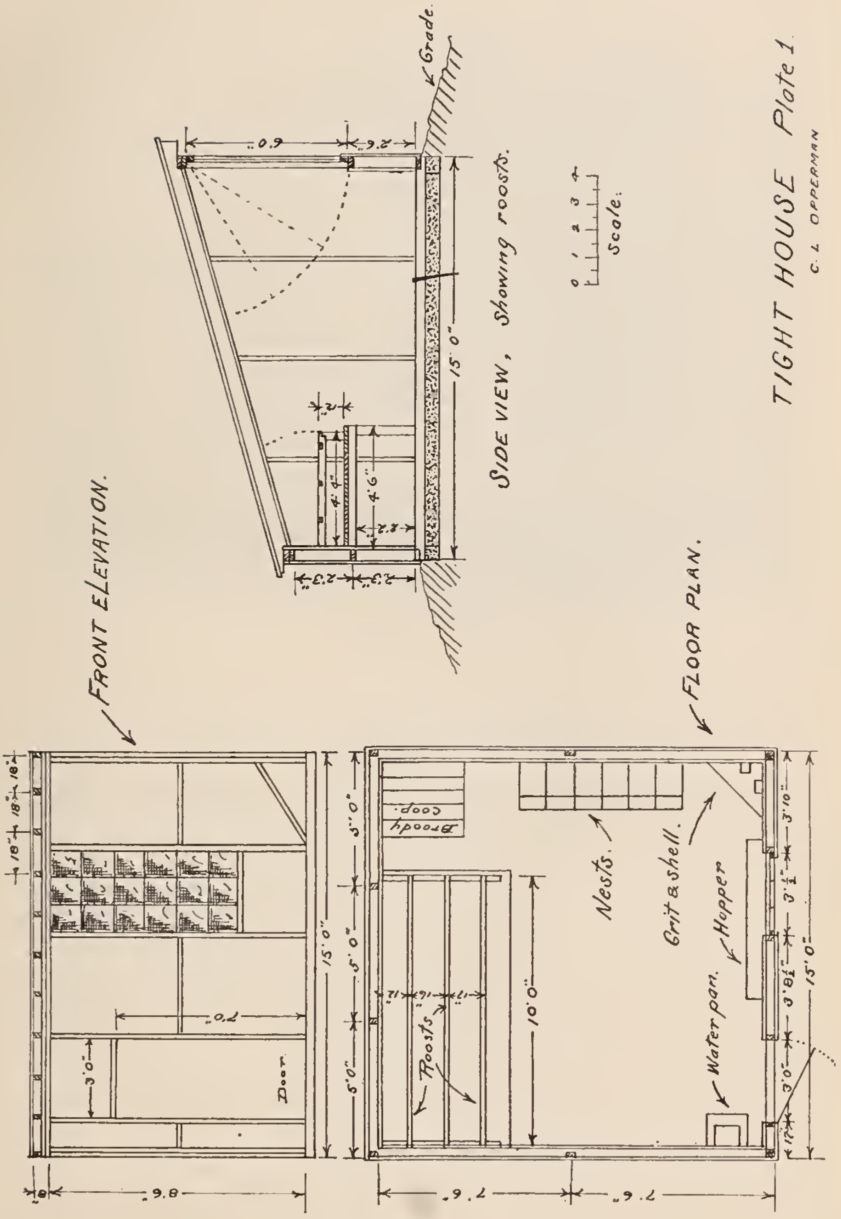
DESCRIPTION OF HOUSE AND PENS USED IN CONDUCTING THE EXPERIMENTS.

The house is 90 feet long by 15 feet wide, 9 feet high in the front and 4 feet 6 inches from sill to plate in the rear. The floor and foundation walls are of cement. The sills are 4 by 4 inch material, and rest on the concrete foundation. The remainder of the framing, with the exception of the rafters, which are 2 by 6 inch material, consists of 2 by 4 inch studding. The sides, ends and roof, with the exception of pen one and the hooded roosts, which are of double-wall construction, are sealed on the outside of the studs and rafters with a cheap grade of tongue and grooved flooring, over which is put a layer of Neponset Red Rope Roofing. The building is divided into six pens, which will hereafter be spoken of as pen I, Tight House; pen II, Glass Front House; pen III, Cloth Front House, with hooded-roost; pen IV, Open-Front House with hooded roost; pen V, Cloth-Front House without hooded roost; pen VI, Open-Front House without hooded roost. Each pen is 15 feet square, and contains approximately 225 square feet of floor space. In the front or south side of each pen there is a door 3 feet wide and 7 feet high. The other openings, such as windows and curtains (which are different in each pen), are described in the detail description of the various pens. The interior fixtures such as feed-hoppers, water-pans, nests and broody coops are exactly the same in each pen.

From May 1, until November 1, all the windows and curtains are open, and the fowls are allowed free access to the yards. The operation of the windows and curtains, as described below, apply only to the months of November, December, January, February, March and the early part of April, since these are the months when the housing of poultry should be carefully considered.

There are many styles of the various houses which these pens represent. It is impossible to embody all the phases in a single pen, but the aim has been to make the general conditions similar to those found in the types which they represent. In order that the reader may have an intelligent understanding of the investigations, and be able to compare the results given in the various tables and discussions in this bulletin, a careful study of the drawings and descriptions of the different pens is essential.

Description of Houses.



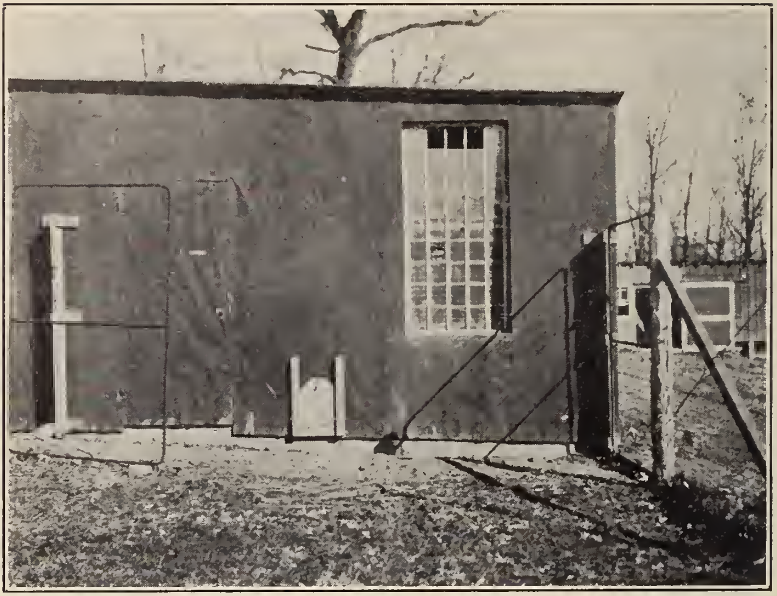
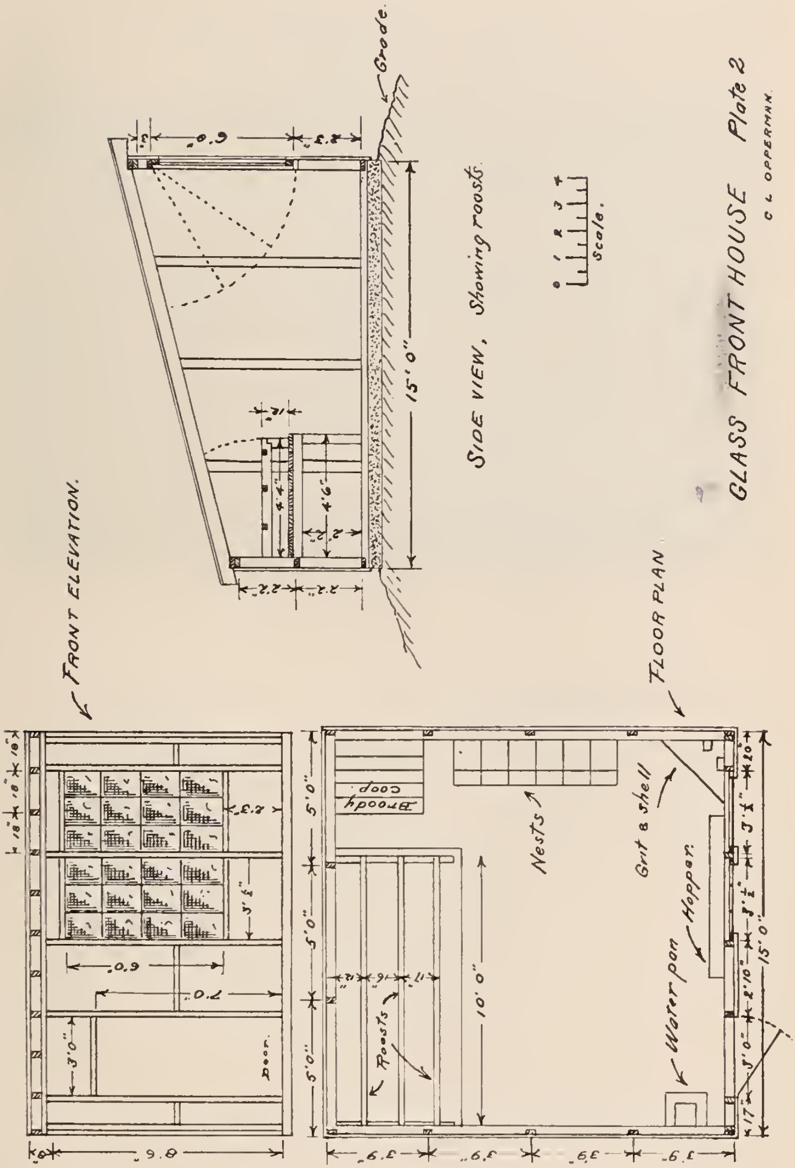


Fig. I, Pen I, showing the three lights removed for ventilation, and the position of the window during the cold months.

PEN I TIGHT HOUSE.

This pen is a type of the tight double-walled poultry house, which until recent years was in general use throughout the country, and may still be found in many localities. It is sealed on the outside and inside of the studs and rafters with tongue and grooved flooring, making a 4-inch dead air space around the entire pen. In the front there is one window (which is an ordinary hot-bed sash) 3 feet wide and 6 feet high. The removal of 3 of the 8 x 10 inch lights, as shown in the illustration, is the only provision made for ventilation during the cold months. The fowls in this pen are confined from November 1, until the early part of April, in order that the influence of the housing conditions may be more definitely determined.



GLASS FRONT HOUSE Plate 2

C L OPPERMAN

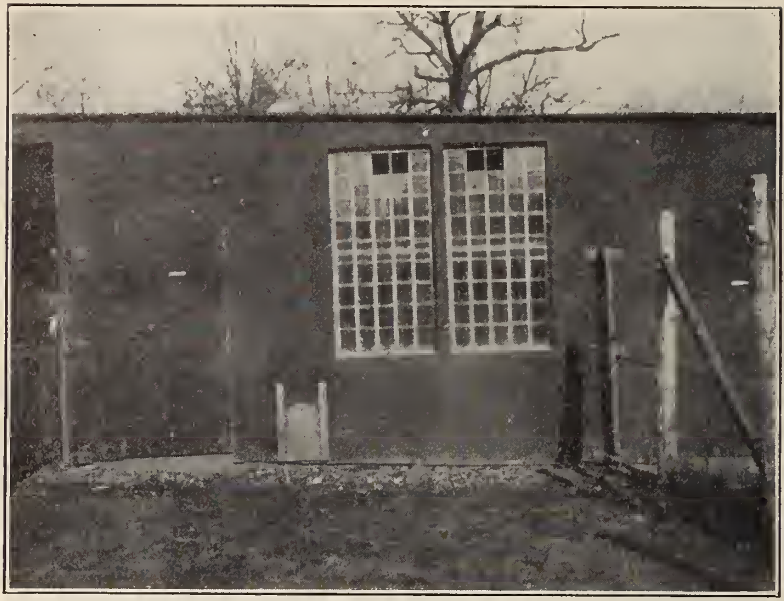
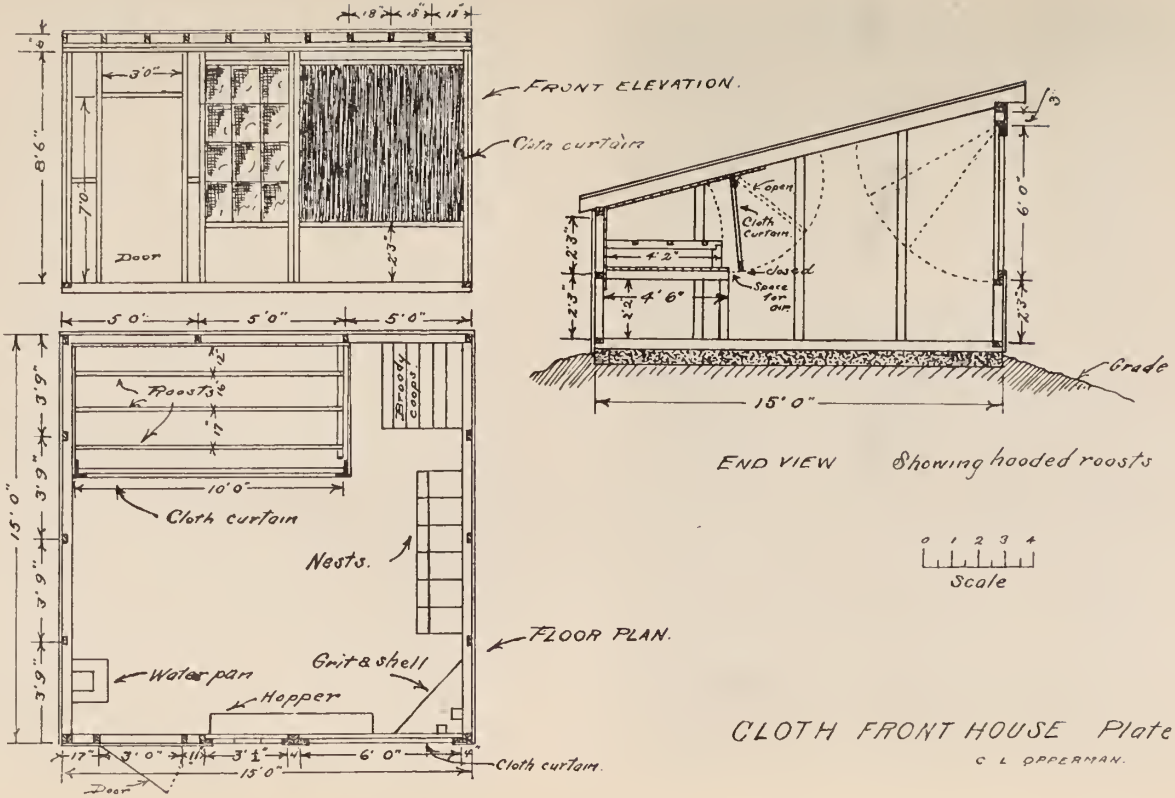


Fig. II, Glass-Front House, showing windows and removable of lights for additional ventilation.

PEN II GLASS-FRONT HOUSE.

This type of house may still be found in many parts of the country, and by some people is considered a practical house. In the front of the pen there are two windows (hot-bed sash) 3 by 6 feet in size, making a total area of 36 square feet of glass surface. Ventilation is provided by opening the windows about two inches at the bottom and removing two of the 8 x 10 inch lights from the top of each sash. This allows the excessive moisture and injurious gases to escape, but does not change the air rapidly enough to keep the straw dry and brittle as in the open and cloth-front pens. The fowls in this pen are confined the same as in pen I.



CLOTH FRONT HOUSE Plate 3.

C L OPPERMAN.

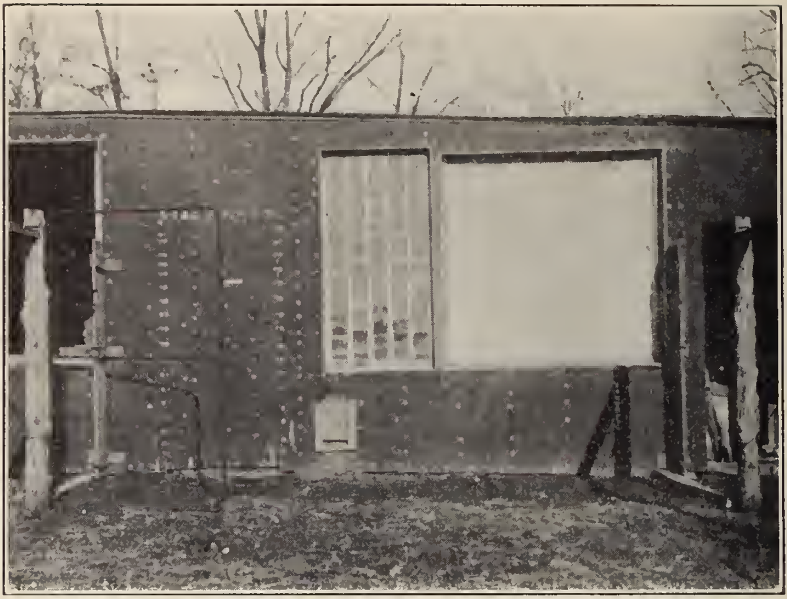


Fig. III, Cloth-Front House with hooded roost; the curtain is always up during the day.

PEN III, CLOTH-FRONT HOUSE, HOODED-ROOST.

This pen is a type of cloth-front poultry house which is at present very popular with the poultrymen of this State. The term "Cloth-Front House," as used in this bulletin, means a house which is open during the day, but protected by a cloth curtain at night. In the front of the pen there is one window (hot-bed sash) 3 x 6 feet, and an opening 6 x 6 feet. The bottom of the opening is 2 feet 6 inches from the floor and extends close up to the eaves. A wooden frame, covered with unbleached sheeting, is fitted to the opening. This curtain is hinged at the top, and is swung in when open, and is always open except on very stormy days and winter nights. The window is stationary, and is used as a source of light when the curtain is down.

The part of the pen which is taken up by the hooded roost is sealed on the inside of the studs and rafters, making a 4 inch dead air space around the ends, back and ceiling of the roost. The front of the roost is covered with a cloth curtain, which is hinged at the top, and hooked to the rafters when not in use. This curtain does not shut tight against the floor of the roost, but is left open about 2 inches (see plate 3) for ventilating purposes, and is only used on nights when the temperature is 35 degrees or below. The fowls in this pen are confined the same as in the pens I and II.

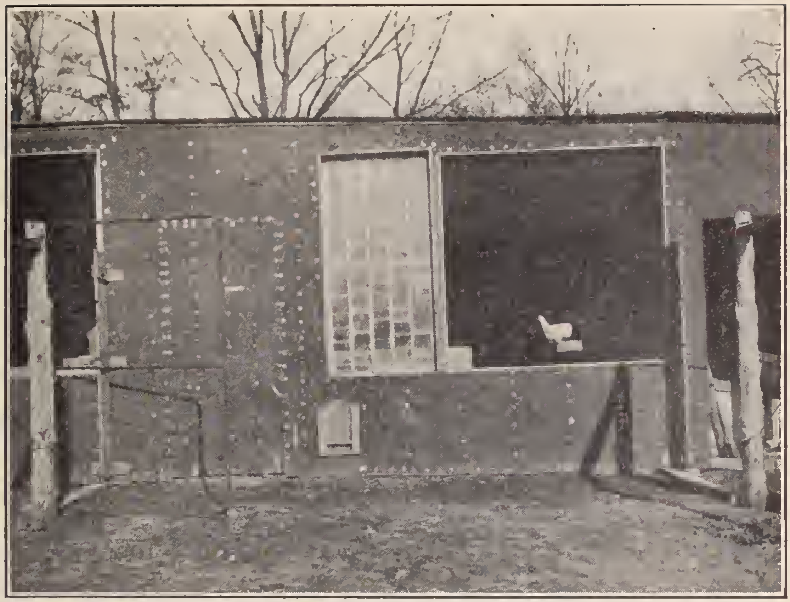


Fig. IV, Open Front, with hooded-roost.

PEN IV, OPEN FRONT, WITH HOODED ROOST.

The construction of this pen is exactly the same as pen III, except that it has no cloth curtain in the front of the pen. The opening (6 feet square) is never covered day or night. The hooded-roost is operated similar to pen III. The fowls in this pen are confined the same as in pens I, II and III.

PEN V, CLOTH FRONT, WITHOUT HOODED ROOST.

This pen is similar to pen III, except that the roost, instead of being hooded, is exposed. The construction of the roost is the same as that shown in plate II. Fig. 3 gives a correct view of the front side of the pen, and the operation of the curtain is the same as described in pen 3. The fowls are allowed free access to the yards at all times.

PEN VI, OPEN FRONT, WITHOUT HOODED-ROOST.

This pen is the same as pen 4, except that the roost is not hooded. Figure 4 gives a correct view of the front side of the pen. The fowls are allowed free access to the yards every day in the year.

METHODS USED IN CONDUCTING THE EXPERIMENT.

As far as it was possible, every condition, except that of housing, has been made the same. A brief description is given of the methods of feeding, breeding, incubation, brooding and rearing in order that the reader may understand the conditions under which the investigations were conducted.

THE FOUNDATION STOCK.

During January, 1907, the Station purchased 100 pure bred White Leghorn pullets from a farmer in an adjoining county. From these pullets, during the months of March and April, a sufficient number of eggs were incubated to rear 300 pullets. On November 1, 1907, these pullets were taken from free range, leg banded and put in the pens, care being exercised to divide them as evenly as possible, according to weight, development and age. Forty pullets were put in each pen, and will hereafter be spoken of as the first generation.

BREEDING.

During the first two years of the experiment, which deals only with the first generation, the males used were purchased from a reliable breeder. They were changed frequently from one pen to another, so as to make breeding conditions equal. Two males were allowed for each pen, alternating so as to have a fresh male every day. This method gave excellent results in fertility.

In the second and future generations, however, each pen will be mated with males which have been hatched from the eggs of the preceding generation in that pen. This method is followed in order that the future generations cannot increase in vitality by the introduction of new blood on the part of the males.

The danger of inbreeding by this method, will be the same in all pens, and should not cause any serious effects, as the males are in no instance full brothers to the females to which they are bred. This is possible by disposing of all the pullets from the dam out of which the males were bred. The males will contain, therefor, one-half the blood of the original sire, and none of the blood of the dams which is in the pullets.

INCUBATION.

To carry out this phase of the experiment, six incubators of the same size and make were purchased. These machines were all operated in one room, and every effort made to have the surrounding conditions equal. The average temperature at which they were operated was between 102 and 103 degrees Fahrenheit.

In selecting eggs for incubating purposes, only those of normal size and shape were used. The same number was selected each day from the different pens, until a sufficient quantity had been procured to fill the machines. They were turned daily and stored in a room where the temperature ranged from 50 to 75 degrees Fahrenheit.

The eggs were tested three times during incubation, in order that the influence of the different pens on the vitality of the germ (or developing embryo) might be observed.

The floor of the incubator cellar was sprinkled every morning after the third day, and on the eighteenth day sponges, which had been saturated with warm water, were introduced in all the machines. The eggs were watched constantly while hatching, and if the hatch was slow or good it was carefully recorded.

Brooding and Feeding the Chicks.

The chickens upon hatching are left in the machines for twenty-four to thirty-six hours. They receive no feed during this time. They are then transferred to the colony brooder houses which are described below.

The first feed consists of infertile eggs which have been boiled hard and then mashed or run through a meat chopper, shells included; they are then mixed with six times their bulk of rolled oats by rubbing together with the hands, a small quantity of fine grit and charcoal being added. This mixture is fed every two and one-half hours for the first three days. About the fourth day they are given a light feed of commercial chick feed in the morning, care being exercised to give just enough so that they will be hungry at 9 A. M. At 9 o'clock they are fed a mixture consisting of two parts by weight of rolled oats, two parts wheat bran, two parts corn meal, one part sifted beef scrap and one-half part of linseed meal. This mixture is fed dry in troughs, and removed after it has been before them for ten or fifteen minutes. At 12.30 the chick food is fed in the litter the same as in the morning, and at 4.30 or 5 o'clock the dry meal mixture is fed, giving all that they will eat. This is continued until the chicks are four or five weeks old, at which time the chick food is gradually substituted by equal parts of crushed corn and wheat. When the chicks are through with the brooders, and put on free range (which is between seven and eight weeks) everything is hopper fed. The hoppers contain crushed corn, wheat, grit, shell and the dry mash mixture which is fed to the laying hens. Green food is supplied from the third day, and consists of cabbage, mangles, onions and green clover.

THE COLONY BROODER HOUSE.

In figure 5 is shown a number of these colony brooder houses. They are 10 feet square. The front wall is 6 feet 6 inches high, and the back 4 feet from floor to roof on the inside. This allows a full-grown person to stand erect in the front part of the house. They are built on runners which are 3 x 10 inches in size. The ends are rounded so that they will slide easily when being moved. (A 4 x 6 inch run-

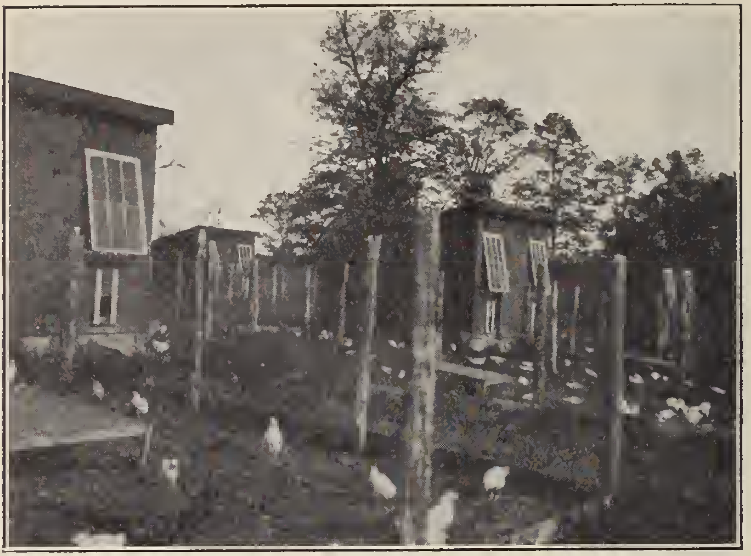


Fig. V, Colony Brooder House.

ner would be more practical.) They are 12 feet long, and extend a foot outside each end of the building.

The floors are of one thickness of tongue and grooved flooring. The outside of the studs and rafters are also covered with the same material, over which is put one thickness of Neponset Red Roof roofing.

A door 3 feet wide and 5 feet high is placed in the center of the front wall with a window on each side. Each window contains six lights of 10x12 glass in one sash. They are hinged at the top and turn out like an ordinary storm window. It is either closely buttoned down or held open at different spaces by hooks of various length. In the center of the rear wall, close up to the plate, there is a ventilating door one foot wide and two feet long. It is hinged at the top and swings out the same as the windows. This opening is very important, since it is difficult to maintain proper ventilation by openings in one side only.

Each house is equipped with two indoor Prairie State brooders, which together will accommodate 100 chicks. These brooders are placed as shown in Figure 6, the lamps facing the front wall. The center partition and gates are made of ordinary building lath, which are placed close enough so that the chicks from one side cannot mingle with those opposite. In practical work this partition need only be temporary until the chicks become accustomed to their brooders.

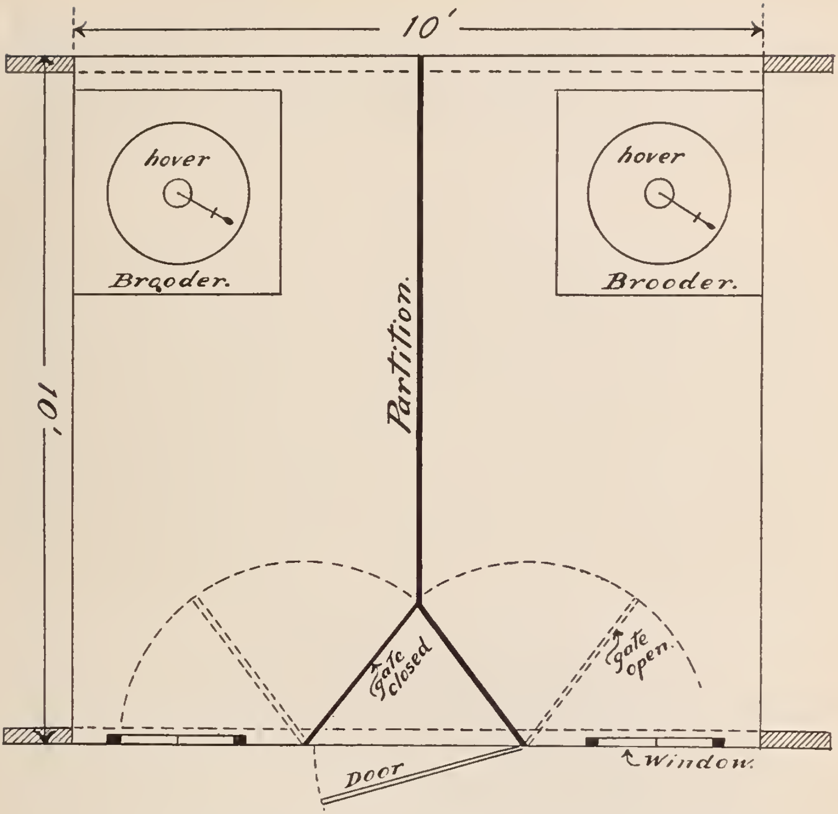


Fig. VI., Floor plan of Colony Brooder house, showing position of brooders.

The chicks are confined to these houses and yards until they are seven or eight weeks old, at which time they are moved to free range and cared for as previously described.

FEEDING THE ADULT STOCK.

GRAIN MIXTURE.

100 lbs.	corn.
100 lbs.	wheat.
100 lbs.	oats.

MASH MIXTURE.

100 lbs.	bran.
50 lbs.	corn meal.
50 lbs.	linseed meal.
50 lbs.	middlings.
50 lbs.	beef scraps.
5 lbs.	salt.
3 lbs.	charcoal.

For the morning feed each pen of 40 fowls received two quarts of the grain mixture, well scattered in a deep litter of straw. Between 8 and 9 o'clock, during the winter months, each pen is given from 3 to 5 lbs. of cabbage or mangles. At noon the grain feed is repeated the same as in the morning. This constitutes all the feeding which is done by hand. The dry mash mixture, grit and shell are retained in hoppers, to which the fowls have free access at all times. The litter is removed from the pens once every thirty days, and the dropping boards are cleaned daily.

THE INFLUENCE ON ENVIRONMENT.

In the forepart of this bulletin will be found working drawings, photographs and a partial description of the pens included in this experiment. While this circumstantial account describes the construction and ventilation of the various pens, it does not mention the environmental conditions of the interior, caused by that particular construction. It is therefore necessary that some account of these conditions be given, in order that the reader may more clearly understand some of the contributary causes for certain variations in the final results. As has been previously stated, the conditions as described below apply to the months of November, December, January, February, March and the early part of April. During the remaining months all pens are freely ventilated, and the fowls allowed the liberty of the yards.

Pen I, Tight House.

The conditions in this pen are more abnormal than those generally found in the average tight poultry house. The air, on account of improper ventilation, is laden with moisture and pregnant with gases and odors from the droppings and litter. While water rarely freezes in this pen, the air is cold, damp and lifeless, even when the sun is bright. This condition is due to the excessive amount of moisture in the air, which has no means of circulating or escaping, except through the small opening at the top of the sash. (See Fig. 1.)

The plumage of the fowls, instead of appearing smooth and glossy, as in the fresh air houses, is dull and rough and suggests a lack of vigor. The combs and wattles are noticeably paler than those of the fowls in the open and cloth-front pens. Is it not remarkable that fowls confined under these conditions should make such an excellent record, as did this pen of birds during the first and second year of the first generation?

Pen II, Glass-Front House.

This pen can properly be named, "the house of extremes." During the day when the sun is bright and warm, the mercury often goes as high as 80 and 85 degrees Fahrenheit, and as night comes on it recedes as rapidly as it ascended. It is a well-known fact that a glass surface will radiate cold as readily as it does heat, which would explain the wide variation of temperature in this pen. The ventilation is sufficient to keep the litter from becoming very damp and the air free from odors and gases.

PEN III, CLOTH-FRONT HOUSE.

In a house of this construction, dampness, gases and odors are entirely absent. The air is at all times fresh, dry and invigorating. The litter, instead of being damp, cracks and snaps as you walk over it. The above conditions also apply to pens 4, 5 and 6.

THE HOODED ROOST.

Many letters have been received asking for information relative to the necessity of hooded-roosts in the poultry house.

The majority of the advocates of the cloth and open-front houses generally recommend the hooded-roost; but the results obtained from the experiments conducted at this Station would indicate that it is not necessary for the climate of Maryland. This point is well illustrated in tables VII and VIII on page 20. The results of these tables show that during the months of November, December, January and February, the fowls in pen 6 (open front and exposed roost) produced as many, and in some instances more, eggs than the fowls in pens 3 and 4, which were equipped with the hooded-roost. Further than this, it will be seen from tables XI and XII that the percentage of total eggs hatched was not greater than that of similar pens unequipped with the hooded-roost. As a matter of fact, the eggs from the fowls in pens of similar construction, except that they did not have the hooded-roost, produced more chicks during the second year than did those of the fowls confined in pens having hooded-roosts. This increased per centage may be accredited to the fact that the fowls in pens 5 and 6 were allowed free access to the yards, and not to the absence of the hooded-roost. Assuming that the above statement is correct, the remaining data is sufficient to demonstrate that the hooded-roost is not essential in this State.

THE INFLUENCE ON THE COST OF CONSTRUCTION.

TABLE 1.—COST OF CONSTRUCTION.

		Total cost.	Cost per bird.
Pen 1	Tight House	$67.18	$1.34
Pen 2	Glass Front	51.24	1.02
Pen 3	Cloth Front, *1, H. R.	54.39	1.09
Pen 4	Open Front, H. R.	54.00	1.08
Pen 5	Cloth Front, *2, E. R.	52.00	1 02
Pen 6	Open Front, E. R.	50.00	1.00

Note—*1, Hooded Roost. *2, Exposed Roost.

It will be seen that the cost of a tight double-walled house is greater than that of any other type. The results of the experiment thus far, show that the fowls kept in the less expensive houses, gave as high returns, and in several instances higher, than those confined in the more costly buildings. To house 1,000 fowls in a house similar to pen I, would cost from five to six hundred dollars more than in the cloth or open-front houses. No further comment should be necessary on this question.

THE INFLUENCE ON THE HEALTH OF THE ADULT FOWLS.

TABLE 2.—MORTALITY RECORD.

		Deaths during first year.	Deaths during second year.	Total Deaths.
Pen 1	Tight House	1	2	3
Pen 2	Glass Front	1	2	3
Pen 3	Cloth Front, H. R.	0	2	2
Pen 4	Open Front, H. R.	4	2	6
Pen 5	Cloth Front, E. R.	4	0	4
Pen 6	Open Front, E. R.	3	3	6

The general health of the fowls in the different pens was practically the same during the first two years. The only apparent difference was the absence of bright red combs in pens I and II, due, no doubt, to the lack of an abundance of pure fresh air. The excessive moisture in pen I (tight house) caused the plumage of the fowls to appear rough and dirty. It was also a noticeable fact that the plumage of the fowls which were allowed free access to the yards at all times (pens V and VI) was brighter and did not have the scraggy appearance of the fowls which were confined during the winter months.

The increased death rate in pens IV and VI might signify that the conditions in these pens were detrimental to the health of the inmates. This, however, is misleading, as the mortality in all the pens is due to such causes as eversion and rupture of the oviduct, choked to death in the trap-nest, apoplexy and hemorrhages; and in no instance as far as determined was death due to the housing conditions under which the fowls were kept.

THE INFLUENCE ON THE COST OF FEEDING.

In computing the cost of the foods consumed by the various pens, the following prices were used: Wheat, $1.00 per bushel; oats, 60 cents per bushel; corn, 80 cents per bushel; bran, $28 a ton; corn meal, $33 a ton; middlings, $28 a ton; linseed meal, $40 a ton; beef scraps, $55 a ton; grit, 50 cents per hundred; oyster shells, 70 cents per hundred, and cabbage at a cent and half a pound. With the exception of wheat, which in all probabilities will soon be reduced to the normal price of $1.00, these prices are liberal, and in several instances higher than those actually paid by this Station.

TABLE III.—FOOD CONSUMED DURING FIRST 365 DAYS.

		Grain, lbs.	Mash, lbs.	Green food, lbs.	Shell, lbs.	Grit, lbs.	Total Value of all foods.	Ave. Cost per hen.	Profit over feed.	No. of hens.
Pen 1......	Tight House........	1553	1041	355	115	12	$49.19	$1.26	$1.80	39
Pen 2.......	Glass Front	1555	1094	360	119	21	50.31	1.29	1.87	39
Pen 3.......	Cloth Front, H. R .	1580	1090	364	123	10	50.69	1 27	1.91	40
Pen 4.......	Open Front, H. R..	1471	961	365	125	9	46.66	1.27	2.06	36
Pen 5.......	Cloth Front, E. R...	1523	1093	337	125	5	48.59	1.31	1.64	37
Pen 6.......	Open Front, E. R..	1491	982	362	112	9	47.14	1.27	1.64	37

TABLE IV.—FOOD CONSUMED DURING SECOND 365 DAYS.

		Grain lbs.	Mash lbs.	Green food lbs.	Shell lbs.	Grit lbs.	Total value of all foods	Av. cost per hen	Profit over feed	No. of hens.
Pen 1	Tight House	1672	738	404	79	7	$45 77	$1.24	$1.47	37
Pen 2	Glass Front.....	1650	877	393	106	20	48 20	1.30	1.64	37
Pen 3	Cloth Front H.R.	1646	905	408	117	19	48.92	1.28	1.67	38
Pen 4	Open Front H R.	1511	776	389	105	10	44.02	1.29	1.47	34
Pen 5	Cloth Front E. R.	1533	935	385	103	4	47.08	1.31	1.41	36
Pen 6	Open Front E. R	1500	789	379	85	10	44 63	1.28	1.70	34

As will be seen by inspection of tables III and IV, there was very little difference in the amount of food consumed by the fowls in the six experimental pens. This would indicate that the environmental conditions, caused by certain construction, had little or no influence on the number of pounds of food consumed. By consulting table III it will be seen that while pen I consumed the same quantity of feed as pen VI, there was an additional profit of 16 cents per hen in favor of pen I. This would be in accordance with the theory that fowls or animals which are exposed to low temperatures will utilize a greater amount of food for the maintenance of bodily heat than will fowls kept under less severe conditions. In this investigation the results of two or more years were not consistent with the above theory. This point is well brought out in table IV, where it will be noted that exactly the opposite results were obtained during the second year, pen VI making a profit of 23 cents more per hen than pen I, and both lots of fowls consuming practically the same number of pounds of feed.

THE INFLUENCE ON EGG PRODUCTION.

TABLE V.—Average Egg Production Per Hen During First 365 Days.

		No. of hens	Total eggs	Eggs per day	% egg production	Av. egg production per hen	Value eggs per hen	Cost of eggs per doz.
Pen 1	Tight House......	39	5,132	14.06	36.05 %	131.6	$3.06	$.114
Pen 2	Glass Front......	39	5,327	14 56	37.33 "	136.6	3.16	.113
Pen 3	Cloth Front H. R.	40	5,516	15.11	37.77 "	137.9	3.18	.111
Pen 4	Open Front H. R.	36	5,119	14.02	38.97 "	142 2	3.33	.107
Pen 5	Cloth Front E. R.	36	4,638	12 7	35.27 "	128 9	2 95	.122
Pen 6	Open Front E. R..	37	4,719	13.05	35.27 "	128.8	2.91	.109

TABLE VI.—Average Egg Production Per Hen During Second 365 Days.

		No. of hens	Total eggs	Eggs per day	% egg production	Av. egg production per hen	Value eggs per hen	Cost of eggs per doz.
Pen 1	Tight House.....	37	4,448	12.18	32 91 %	120.2	$2 71	$.123
Pen 2	Glass Front......	37	4,834	13.24	35.78 "	130.6	2 94	.119
Pen 3	Cloth Front H. R.	38	4,999	13.66	35.94 "	113 6	2.95	.116
Pen 4	Open Front H. R.	34	4,211	11.53	33 91 "	123 9	2.76	.124
Pen 5	Cloth Front E. R.	36	4,411	12.08	33 55 "	122.5	2.72	.128
Pen 6	Open Front E. R.	34	4,552	12.38	36.41 "	133.	2.98	.115

Rather than to enter upon a lengthy discussion of the influence of construction on egg production as set forth in tables V, VI, VII, VIII, IX and X, the writer would prefer to apply the results in the following practical manner:

First—That egg production is largely influenced by feeding, and the individual hen. In other words, if a hen is born with the power to produce 200 eggs in 365 consecutive days, she is, with proper feeding and sanitary conditions, most likely to make such a record regardless of the type of house in which she is confined. This point is well shown in tables IX and X. For example, it will be seen that during the first and second year the percentage of fowls producing from 126 to 150 eggs was greater for pen I than for pen VI. This was also true of fowls producing from 151 to 175 eggs during the first year, but during the second year the percentage was greater in pen VI. The column headed 126 to 150 eggs is the most important, since it represents the average maximum record of the domestic fowl. This state-

TABLE IX.—INFLUENCE ON INDIVIDUAL EGG PRODUCTION DURING FIRST 365 DAYS.

	Per cent. of hens producing from	No. of hens.	10 to 50 eggs.	51 to 75 eggs.	76 to 100 eggs.	101 to 125 eggs.	126 to 150 eggs.	151 to 175 eggs.	176 to 200 eggs.	201 and over.	Av. eggs per hen.
Pen 1	Tight House	39	5.3%	7.7%	12.8%	20.5%	28.2%	23.1%	2.6%	0. %	131.6
Pen 2	Glass Front	39	7.7 “	7.7 “	10.2 “	17.9 “	25.6 “	10.2 “	17.9 “	2.6 “	136.6
Pen 3	Cloth Front, H. R.	40	5. “	5. “	10. “	17.5 “	32.5 “	20. “	10. “	0. “	137.9
Pen 4	Open Front, H. R.	36	0. “	0. “	13 9 “	22.2 “	27.7 “	16.6 “	11.1 “	5.5 “	142.2
Pen 5	Cloth Front, E. R.	36	*25. “	2.7 “	19.4 “	13.9 “	19.4 “	11.1 “	2.7 “	5.5 “	128.9
Pen 6	Open Front, E. R.	37	5.4 “	5.4 “	18.9 “	27. “	21.6 “	13.3 “	8.1 “	0. “	128.8

* NOTE.—Due to several hens refusing to lay in trap nests.

TABLE X. INFLUENCE ON INDIVIDUAL EGG PRODUCTION DURING SECOND 365 DAYS.

	Percentage of hens producing from	No. of hens.	10 to 50 eggs.	51 to 75 eggs.	76 to 100 eggs.	101 to 125 eggs.	126 to 150 eggs.	151 to 175 eggs.	176 to 200 eggs.	201 and over.	Av. eggs per hen.
Pen 1	Tight House	37	2.7%	10 8%	16.2%	35.1%	24.3%	5.4%	5.4%	0. %	120.2
Pen 2	Glass Front	37	0. “	10.8 “	5.4 “	24.3 “	37.8 “	13.3 “	5.4 “	2.7 “	130.6
Pen 3	Cloth Front, H. R.	38	2.6 “	7.8 “	13.1 “	21. “	23.6 “	26.3 “	5.2 “	0. “	131.6
Pen 4	Open Front, H. R.	34	5.8 “	5.8 “	20.5 “	20.5 “	20.5 “	23.4 “	2.9 “	0. “	123.9
Pen 5	Cloth Front, E. R.	36	*22.1 “	8.3 “	11. “	22.1 “	8.3 “	16.6 “	5.5 “	5.5 “	122.5
Pen 6	Open Front, E. R.	34	2.9 “	2.9 “	8.8 “	41.1 “	20.5 “	11.7 “	2.9 “	2.9 “	133.

* NOTE.—Due to several hens refusing to lay in trap nest.

ment is not intended to convey the idea that it is impossible for individual hens to make a higher record. The figures given in tables IX and X show that not a few produced from 150 to 200 eggs, but they do not prove that such performances were the result of environmental conditions. To compare still higher records, we find that during the pullet year 2.6 per cent. of the fowls in pen I made a record of from 176 to 200 eggs. Of the fowls in pen VI, 8.1 per cent. produced that number. The percentages in this column for table X are diametrically opposite, which clearly demonstrates the influence of the individual hen on the final result.

Second—That if egg production is influenced by environmental conditions, the following interpretation will be of economic value, since it proves that expensive houses are not always necessary to realize a maximum profit.

During the first year the birds in pen I (table V) made a profit of 15 cents more per hen than did those in pen VI, and to realize this increased profit called for an additional investment of 34 cents per hen in construction. (See table I.) This would leave a balance of 19 cents per hen or $7.60 in favor of the fowls in open house. The above statement will also apply to pens II, III, IV and V, and leave even a higher balance in favor of these types.

Third—That with proper ventilation the glass-front house (pen II) has proven to be a very practical house for winter egg production.

Fourth—That the increased egg yield, which might have been caused by the additional protection of the hooded-roost, was too slight to justify the increased investment necessary for its construction.

The foregoing conclusions regarding egg production are for the first generation only, and may be completely changed by the results obtained from the work with future generations.

TABLE VII.—Winter Egg Production, First Year.

		No. hens	November	December	January	February	Total	Av. eggs per hen
Pen 1	Tight House.....	40	135	321	480	619	1555	38.6
Pen 2	Glass Front......	40	105	256	531	599	1491	37.2
Pen 3	Cloth Front H. R.	40	121	295	477	568	1461	36.5
Pen 4	Open Front H. R	40	137	390	520	609	1656	41.4
Pen 5	Cloth Front E R.	40	99	220	476	581	1376	34.4
Pen 6	Open Front E. R.	40	116	256	387	781	1540	38.5

TABLE VIII.—WINTER EGG PRODUCTION, SECOND YEAR.

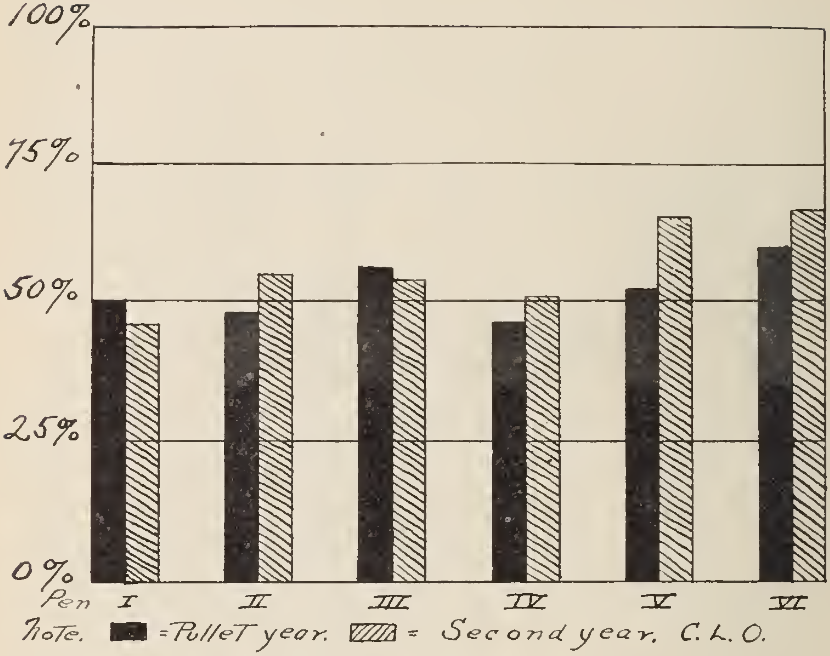
		No. hens	November	December	January	February	Total	Av. eggs per hen
Pen 1	Tight House......	39	27	156	342	455	980	25 1
Pen 2	Glass Front......	39	30	120	376	510	1036	26.5
Pen 3	Cloth Front H. R.	40	26	59	350	505	940	24 1
Pen 4	Open Front H. R.	36	34	30	223	474	761	20.8
Pen 5	Cloth Front E. R.	36	28	63	212	420	723	20 1
Pen 6	Open Front E. R.	36	17	55	292	492	856	23.7

THE INFLUENCE ON THE VITALITY OF THE DEVELOPING EMBRYO.

It is evident from the results of table XI, that the influence of construction is not very noticeable during the pullet year of the first generation. The number of infertile eggs, dead germs, fully formed chicks which died in the shell, and eggs which pipped but did not hatch, are inconsistent when compared with the various pens. It is, therefore, obvious that it would be a misconception to assume that they were caused by the environmental conditions in the different pens. If this be true the causative factor must be sought elsewhere. The

TABLE XI.—THE INFLUENCE ON THE DEVELOPING EMBRYO. 1908.

Pen.	House.	No. of hatches.	No. of eggs set.	No. of infertile eggs.	No. of dead germs between 7 and 0 days.	No. of fully formed chicks dead in the shell.	No. of eggs pipped but did not hatch.	No. of chicks hatched.	No. of cripples.	Percentage hatched of total eggs.	Percentage hatched of fertile eggs.	No. of broken eggs.
1	Tight House......	3	300	25	37	62	24	151	9	50 5 %	54 9 %	1
2	Glass Front......	3	300	21	54	52	28	143	7	47 9 "	51 2 "	2
3	Cloth Front H. R.	3	300	13	57	43	16	167	8	56 4 "	59 8 "	4
4	Open Front H. R.	3	300	35	46	60	19	140	10	46.6 "	52.8 "	0
5	Cloth Front E. R.	3	300	14	53	58	18	156	9	52.1 "	54.5 "	1
6	Open Front E. R.	3	300	20	30	50	21	178	11	59 5 "	63.5 "	1
	TABLE XII.					1909.						
1	Tight House......	2	257	39	35	57	6	118	8	46.2 %	54.6 %	2
2	Glass Front......	2	257	15	26	55	19	142	11	55 2 "	58.2 "	0
3	Cloth Front H. R.	2	257	11	35	58	15	37	12	53.9 "	58 5 "	1
4	Open Front H. R.	2	257	22	41	56	7	130	14	50 7 "	51 2 "	1
5	Cloth Front E. R.	2	257	13	27	42	6	164	8	65 "	68.6 "	5
6	Open Front E. R.	2	257	8	23	40	15	170	5	66.4 "	68 5 "	1



productive power of individual hens' eggs, as set forth in table XIII, would furnish a logical solution of the problem. For example, we will compare hen No. 73 of pen I, and hen No. 259 of pen VI. Out of 21 eggs which were incubated from hen No. 73, one chick was hatched; and from 11 eggs of hen No. 259 not a chick was produced. On the other hand, there are many hens, in any of the given pens, whose eggs hatch well (see first five hens of any pen given in table XIII). Such variations are often attributed to the lack of attention on the part of the male bird, which is with the flock, but the fact that the eggs of hens Nos. 73 and 259 tested over 50 per cent. fertile, is indicative that the males maintained the powers of fertilization. In the light of what has gone before, it can be readily seen how five or ten hens could easily influence, for better or worse, the number of total eggs hatched. The percentage of total eggs hatched from the six pens during the first year, indicates that 12 per cent. was the greatest increase of any one pen over the over five; and a variation of 15 or 20 per cent. in the second year would probably be caused by such factors as ventilation, range, etc.

From table XII and figure 6, which is a graphic illustration of the results in tables XI and XII, the following points are to be noted:

(1) That all pens except I and III showed an increase in the number of total eggs hatched during the second year. We would naturally expect a slight increase, as the eggs from two-year-old fowls

TABLE XIII.—HATCHING RECORD OF INDIVIDUAL HENS' EGGS.

Pen	No. leg band.	No. of hatches.	No. of eggs.	No. infertile.	No. dead germ.	No. fully formed chicks dead in the shell.	Broken eggs.	Pipped, but did not hatch.	No. hatched.	Per cent. of total eggs hatched.	Per cent. of fertile eggs hatched.
1	56	4	7	0	0	0	0	1	6	85.7	85.7
	58	3	8	0	0	1	0	1	6	75.	75.
	88	5	17	0	1	1	0	1	14	82.3	82 3
	83	5	19	0	0	2	0	0	17	89.4	89.4
	84	5	27	1	2	4	0	0	20	74.1	76.9
	69	4	7	0	4	2	0	0	1	14.2	14.2
	73	5	21	12	6	1	0	1	1	4.8	11.1
	81	4	10	4	4	1	0	0	1	10.	16.6
	87	5	20	8	3	5	0	2	2	10.	16.6
	82	5	15	2	3	7	0	0	3	20.	23.1
2	95	5	18	1	4	0	0	0	13	72.2	76 4
	101	5	23	2	1	3	0	0	17	73.9	80.9
	116	5	24	0	0	5	0	1	18	75.	75.
	130	4	18	0	2	0	0	0	16	88.8	88.8
	103	4	11	0	2	1	0	0	8	72.7	72.7
	93	3	7	2	1	3	0	0	1	14.2	20.
	117	4	13	0	6	4	0	0	3	23.1	23.1
	118	5	12	2	5	3	0	1	1	8.3	10.
	124	4	19	0	6	8	0	4	1	5.2	5.2
	126	4	11	1	4	3	0	0	3	27.2	30.
3	151	4	14	0	0	0	0	1	13	92.8	92.8
	157	5	17	0	1	2	0	2	12	70.5	70.5
	164	4	15	0	0	1	0	0	14	93.1	93.1
	136	5	13	1	2	0	0	0	10	77.	83.3
	140	5	13	0	2	0	0	1	10	77.	7.7
	138	4	10	0	4	3	0	2	1	10.	10.
	170	4	17	1	10	2	0	0	4	23.5	25.
	149	5	18	0	5	9	0	0	4	22 2	22.2
	145	4	10	0	5	1	0	1	3	30.0	30.
	158	5	19	1	4	6	0	1	7	36 8	38.8
4	183	4	14	0	1	2	0	0	11	78.5	78.5
	190	5	23	0	3	1	0	0	19	82.6	82.6
	201	4	17	0	0	1	0	0	16	94.1	94.1
	86	5	7	0	0	0	0	0	7	100.	100.
	178	5	10	0	1	1	0	0	8	80.	80.
	179	4	19	3	6	6	0	1	3	15.7	18.7
	187	4	12	0	9	3	0	0	0	0.	0.
	200	5	27	2	6	12	0	1	6	22.2	24.
	176	5	20	3	2	6	0	4	5	25.	29.4
	186	5	21	4	7	3	0	1	6	28.5	35.2

5	239	4	26	1	2	0	0	1	22	84.6	88.
	215	5	16	1	1	2	0	0	12	75.	80.
	221	4	17	0	2	0	0	0	15	88.2	88.2
	229	5	15	1	0	2	0	0	12	80.	85.
	226	5	25	0	1	5	1	0	18	72.	72.
	247	2	10	0	4	3	0	2	1	10.0	10.
	250	5	17	0	7	7	0	0	3	17.5	17.5
	211	4	9	0	1	6	0	0	2	22.2	22.2
	238	5	29	1	3	12	0	1	12	41.3	42.8
	214	2	8	1	2	1	1	0	3	37.5	42.8
6	258	4	14	1	0	0	0	0	13	92.8	100.
	265	4	16	0	0	0	0	0	16	100.	100.
	266	5	15	1	0	0	0	0	14	93.3	100.
	276	5	19	0	0	1	0	0	18	94.7	94.7
	282	4	14	0	1	2	0	0	11	78.5	78.5
	259	3	11	4	4	3	0	0	0	0.	0.
	263	5	26	1	2	8	0	3	12	46.1	48.
	272	4	10	2	2	3	0	0	3	30.	37.5
	290	4	9	2	0	4	0	0	3	33.3	42.8
	255	5	23	0	5	4	0	3	11	47.8	47.8

will generally hatch a larger percentage than those produced by pullets, due to the fact that they are more mature, and their eggs are uniform in shape and size. The decrease in pens I and III is not great enough to be of importance, and is undoubtedly due to the action of individual hens' eggs (see table XIII).

(2) That the eggs from the fowls in pens V and VI produced 20 more chicks from every hundred than did those from the fowls in pen I. A result of this kind proves beyond a doubt that an abundance of fresh air, both day and night, and free access to yards or range are essential factors in the production of fertile eggs, which when incubated will hatch a high percentage of vigorous chicks.

It might be well to restate, that the cock birds which were used during the first year were also used the second year, and frequently changed from pen to pen, which would make this factor equal.

THE INFLUENCE ON THE PROGENY.

The influence of construction on the vitality of the developing embryo and the progeny are the most important phases of the investigation. The success of large or small poultry farms largely depends on the vigor and productive power of the breeding stock; for unless the poultryman is able to hatch 50 per cent. of the eggs incubated, and rear 75 per cent. of the chicks, failure is inevitable. It is, therefore, evident that if a certain type of construction has an influence on the breeders which will tend to increase the number of total eggs hatched, and to produce strong, vigorous chicks, its commercial importance is inestimable.

From table XIV the following points are apparent:

(1) The results of hatches one and two would indicate that the influence of environmental conditions were not positive enough to be

TABLE XIV.—Brooding Record For Pullet Year.

Pen No.	Type.	No. of hatch.	Date put in brooder.	No. put in brooder.	Death during first four weeks.	Deaths during second four weeks.	Deaths on free range	% of deaths to total chicks	No. Reared
1	Tight House........	1	Mar. 2	48	2	* 0	*1 0	4.1	46
2	Glass Front	1	" "	45	6	0	0	13 3	39
3	Cloth Front, H. R..	1	" "	60	3	0	0	5.	57
4	Open Front, H. R..	1	" "	36	6	0	0	16.6	30
5	Cloth Front, E. R..	1	" "	47	3	0	0	6.3	44
6	Open Front, E. R..	1	" "	50	4	0	0	8.	46
1	Tight House........	2	Mar. 31	52	6	0	*1 0	11.5	46
2	Glass Front	2	" "	61	6	0	0	9 8	55
3	Cloth Front, H. R..	2	" "	62	6	1	0	11.2	55
4	Open Front, H. R..	2	" "	55	3	2	0	8.1	50
5	Cloth Front, E. R..	2	" "	59	3	0	0	5.1	56
6	Open Front, E. R	2	" "	65	5	0	0	7.6	60
1	Tight House........	3	May 1	51	3	0	3	11.7	45
2	Glass Front	3	" "	37	4	4	3	29.7	26
3	Cloth Front, H. R..	3	" "	44	6	5	1	27.2	32
4	Open Front, H. R..	3	" "	47	6	9	2	36.1	30
5	Cloth Front, E. R..	3	" "	45	5	3	0	17.7	37
6	Open Front, E. R ..	3	" "	61	0	1	0	1 6	60

TABLE XV.—Brooding Record For Second Year.

1	Tight House........	1	Mar. 27	50	8	0	4	24.	38
2	Glass Front	1	" "	50	6	0	9	30.	35
3	Cloth Front, H. R..	1	" "	50	8	0	13	42.	29
4	Open Front, H. R..	1.	" "	50	6	0	9	30.	35
5	Cloth Front, E. R..	1	" "	50	2	3	12	34.	33
6	Open Front, E. R..	1	" "	50	0	0	3	6.	47
1	Tight House........	2	Apr. 21	60	6	See note at bottom of table *2	16	36.6	38
2	Glass Front	2	" "	60	18		12	50.	30
3	Cloth Front, H. R..	2	" "	60	20		11	51.6	29
4	Open Front, H. R..	2	" "	54	21		10	57.4	23
5	Cloth Front. E. R..	2	" "	60	2		20	36.6	38
6	Open Front, E. R..	2	" "	60	3		8	18 3	49

Note—*1—Sold at age of eight weeks.
*2—Were put on free range on account of disease.

of significance. The per cent. of deaths to total chicks for hatch one would show that the progeny of pen I (tight house) were stronger than those of any other pen. While the above statement may be correct, mention should be made of the fact that the offspring from the six experimental houses were so near alike in the matter of vitality, that it was impossible to say positively which one gave the best results.

(2) That for hatch three there is a noticeable variation in favor of pen 6. It is also apparent, with the exception of pens VI and I, that the mortality was greater than in the previous broods. This increased death rate was due to the intense hot weather, and to placing this hatch in yards which had been used by a previous lot of chicks. These disadvantages, however, were shared alike by all pens.

The variations as mentioned above cannot be associated with the environmental conditions. This point is made clear by comparing the percentage of deaths in hatch II with those of following hatch. Such a comparison would show that the death rate for pen I in hatch III was identical to that of hatch II. This would indicate that the chicks of this pen were as fully resistant to disease as were those of pen VI. Even granting that they were not, their percentage of deaths is so much less than that of the other fresh-air houses (table XIV, hatch 3) that it is impossible to charge the results of this hatch to housing conditions.

In order to determine, with some degree of certainty, the influence of construction on the offspring of pullets of the first generation, the conditions under which the parent stock are confined would have to be of a more extreme nature than was the case in this experiment.

THE INFLUENCE ON THE PROGENY DURING THE SECOND YEAR.

Before discussing the results of the second year's work, a brief description should be given of the disease which affected all the chicks. The exact cause was not determined, but after thoroughly cultivating the yards which were infected, there is every reason to believe that it was due to soil contamination. There has not been a single case of the disease this spring, and several hundred chicks have been reared on the ground, which was badly contaminated previous to cultivation.

The principal symptoms of the disease are depression, loss of appetite, drooping wings, weakness and rapid loss of weight. The administration of various drugs had little or no effect in checking the disease. The only remedy which proved effective was to put the sick birds on free range. This seemed to strengthen them, and in a few weeks they would apparently overcome the trouble. The pullets which survived were put in the pens during November, and have made very good egg yields. The disease does not appear to be transmitted, as the progeny of these pullets showed no indication of it. While it is unfortunate that disease should break out in an experiment of this kind, it nevertheless furnished ample opportunity for observing the resistance of the chicks to disease.

The important points to be noted in table XV are first, that the progeny of pen VI were more resistant to disease than those of any other pen. Second, that the offspring from the tight house were fully as resistant as those of any pen except VI. This would indicate that the parent stock were still vigorous in spite of their abnormal housing conditions. All results point to the fact that the most desirable conditions for maintaining the vigor and productive power of the breeding stock are those found in the open-front house with exposed roost. As dropping water is said to wear away stone, so reiteration is necessary to press a truth home. It cannot be too strongly emphasized, that fresh air and freedom for the breeding stock are very essential if the poultryman is to successfully renew his flock.

SUMMARY.

The following conclusions are a summary of the data obtained from the work with the first generation. The experiment is in progress at the present time, and will be continued for several generations. Future results will be published from time to time as the work is completed.

(1) That the cost of tight double-walled construction is greater than that of any other type. In the experiment here discussed it was found that the fertility and hatching quality of eggs were very much better in fresh-air houses of less expensive construction.

(2) So far as the present data indicates, the general health of the adult fowls was not seriously impaired by environmental conditions.

(3) The amount of food eaten by the fowls does not appear to be influenced by housing conditions.

(4) The present data indicates that egg production is largely influenced by the action of individual hens, rather than by environmental conditions. This, of course, applies to the first generation. It may be found that future generations will show a more definite variation in favor of the fresh-air houses, or vice-versa.

(5) That the fertility and hatchability of eggs is much better in the open and cloth-front houses, where the fowls are allowed free access to yards or range. This is more noticeable in the second year of the first generation, and additional data not included in this paper shows a wide variation in favor of these conditions.

(6) That the progeny of fowls in fresh-air houses, having free access to yards or range, are more resistant to disease than those of the fowls which are maintained in houses of other construction, and not having the liberty of the yards during the breeding season.

PRACTICAL POULTRY APPLIANCES.

Since the institution of the system known as "dry feeding," a great many hoppers have been designed and manufactured. The most serious objection to the majority of the hoppers is that they allow too much waste, and are difficult to keep in a clean condition. When used in the laying pens, they are constantly filled with straw or litter, which the hens kick in while scratching for grain. Several of the manufactured hoppers are designated as "self-feeders," which in a sense is true. The great difficulty is that the mash usually clogs and packs in the narrow opening used to supply the feed to the trough or box. If this opening is made too wide, the mash is forced too rapidly into the trough; and consequently a large amount is wasted as the fowls will pick and scratch in it very much as they would in a pile of dirt or rubbish.

Since it is necessary that the mash be maintained in hoppers where the fowls may eat of it at will, it is desirable to construct and install hoppers which will overcome these difficulties. Hoppers which will meet these requirements for both indoor and outdoor use have been designed by the writer, and drawings and instructions for making the same are given herewith. These hoppers have been in use for several years, and have proven satisfactory.

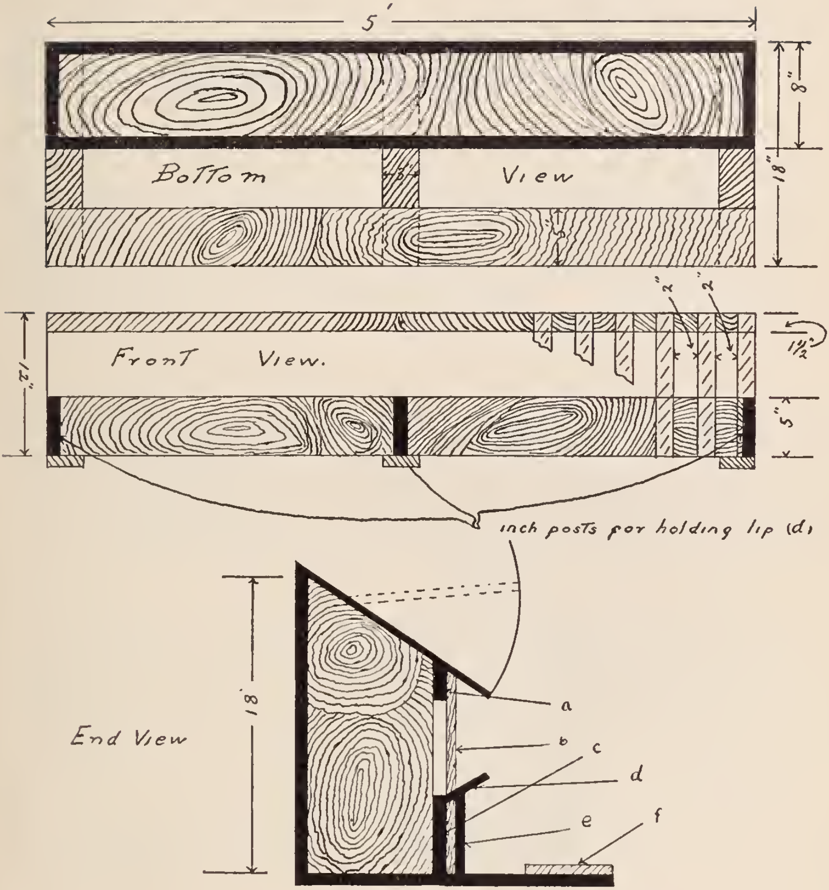


Fig. 8—Dry mash hopper for laying hens. C. L. O.

A DRY MASH HOPPER FOR LAYING HENS.

In figure 8 is shown bottom, front and end views of a hopper for use in the laying pens. It is 5 feet long and 8 inches wide, outside measurements. These dimensions do not include the platform on which the fowls stand to eat. The board which forms the front of the trough (see board "c" in end view) is 5 inches wide. The top strip on the front side, designated by arrow "a" in the end view, is one and one-half inches wide, and for nailing the lath to and also for strengthening the hopper. The laths "b" are placed two inches apart, inside measurements. This provides ample space for the largest fowls to eat with ease. Lip "d" is used as a catch-all to prevent waste, and is fastened in position by nailing to the three posts indicated by arrow "e". Arrow "f" shows an end view of the five inch board which the fowls stand on while eating. This platform which is on a level with the bottom of the hopper, should be at least one foot from the floor of the pen. This may be accomplished by hanging the hopper to the side wall or by placing it on legs. The entire hopper can be constructed from ordinary box lumber and at practically no expense.

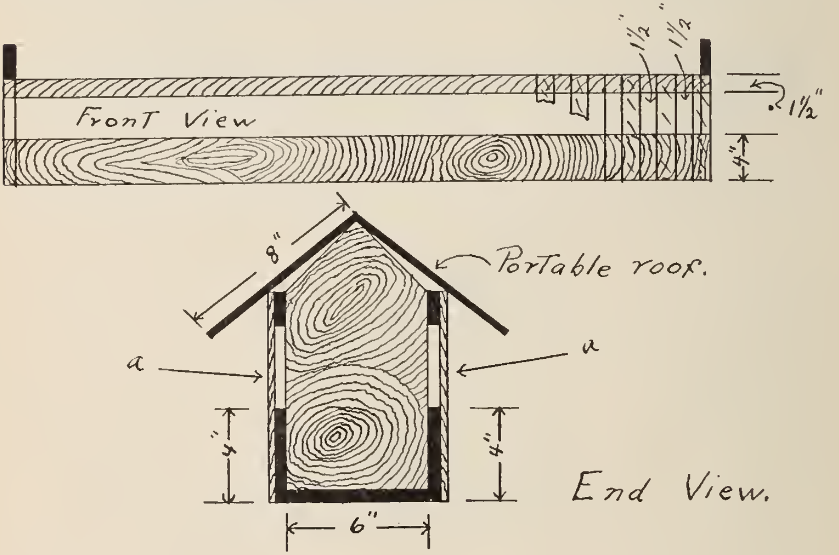


Fig. 9—Outdoor feed hopper for young stock. C. L. O.

Figure 9 gives a front and end view of an outdoor hopper for growing stock. A practical length for this kind of hopper is six feet. There is, however, no restrictions on this point as it may be any length desired by the builder. The construction of the hopper is such that the birds may eat from both sides. The two side boards which form the trough are four inches wide. The width of the bottom board and end pieces is six inches. The laths "a" are placed one and one-half inches apart, inside measurements. The portable roof is made of one eight inch and one nine inch board, and extends well over the sides of the hopper so as to keep out driving rains. The hopper can be made of ordinary box lumber and if well painted will last for several years.

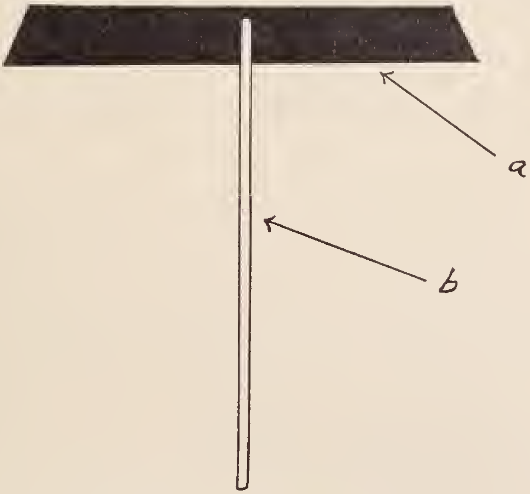


Fig. 10—Scraper for dropping board. C. L. O.

In figure 10 is given a sketch of a scraper for cleaning the dropping boards. The blade, indicated by arrow "a" is made of three-sixteenths or one-fourth inch sheet steel. The bottom edge is twenty-four inches long and the top twenty-two inches. The width of the blade is four inches. The handle is made of three-quarter inch pipe and threaded on one end. A hole is bored near the top in the centre of the blade. This is threaded with an ordinary tap and the handle is then securely screwed in place. A scraper made in this manner will last a lifetime, and prove to be a very practical tool.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

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WHEAT—VARIETY TESTS AND DISEASES.

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INTRODUCTION.

The testing of varieties of wheat has always been given considerable attention at this Station. The last report made on variety tests was in Bulletin 62, published in 1898. This bulletin will deal only with the varieties grown since that date and will be only a preliminary report and treat of a few phases of the subject which seems to be of immediate interest to Maryland farmers. Since 1907 the wheat investigations have been conducted in cooperation with the United States Department of Agriculture.

Many farmers make the mistake of sowing year after year a variety of wheat which yields several bushels less per acre under their condition than some other variety would do under the same conditions. Often the only reason why a particular variety has become popular in certain localities is because when first introduced, it gave an extra high yield, due more to exceptionally good treatment in a favorable season than high-yielding qualities in the variety. When a new variety is introduced in a community or on a farm, it should always be grown in the same field and beside a well-known or standard variety of the community or farm. It is impossible to determine the possibility of a variety when comparing a field on one end of the farm with another on the other end, or what is still worse, comparing one man's field with that of his neighbor. It is seldom found in Maryland that two fields of the same farm are alike in fertility or adaptability to the same crop. Unless a variety is exceptionally good or poor it will take more than one season to determine its merits. A glance at Table II will show that some varieties will yield one year much better than others, while the next year much less. This is due to the fact that some seasons are much better suited for certain varieties than others. A good illustration of this is the Fultz variety, which it will be noted yielded over 30 bushels in 1908, 18 bushels in 1909 and over 29 bushels in 1910.

It is a much safer and more paying proposition to grow a variety which, while not yielding exceptionally high at any time, will produce good yields every year. A good illustration of this is Deitz Longberry (Table II). In this it will be noted that the variation in yields between the good and poor years was a little less than three bushels.

The soil on which these tests have been made is a clay loam and for the most part poorly drained. These tests followed corn one year and wheat stubble fallow the next. For the corn, crops of crimson clover or manure were plowed under. At the time of seeding the wheat commercial fertilizer was applied at the rate of 400 pounds per acre. The fertilizer was composed of:

Acid rock, 14 per cent	1,400 pounds.
Muriate of Potash	200 pounds.
Tankage	300 pounds.
Nitrate of Soda	100 pounds.
Total	2,000 pounds.

This fertilizer analyzed approximately phosphoric acid 9 to 10 per cent., potash 5 per cent., and nitrogen 2 per cent.

TESTS OF VARIETIES.

In the tests given in the following tables, Fultz was used as a check on the soil and as a standard for comparing the different varieties. The yields given in Tables II to VI inclusive, are the corrected yields, or what the whole field would have yielded had it all been planted to that particular variety. It will be noted from Table II that 26 varieties yielded better than Fultz, while 12 yielded within one bushel of it. It will also be noted that the difference in yield between many of the varieties is very slight, and characters other than yield would have to determine one's choice. In this case quality should be given the most weight.

Table I gives the yields of a number of varieties tested for the years 1899 to 1907, inclusive.

Table II gives the yields of varieties tested in the years 1908 to 1910, inclusive. The varieties are arranged in the table according to the average yield for three years. It will be noted that the five highest yielding varieties are Bearded Purple Straw, Deitz Longberry, China, Turkish Amber and Currell's Prolific.

Table III gives the yields of varieties tested in 1908, not included in table II. These varieties were grown only one year, after which they were discarded, owing to poor quality of grain and badly mixed seed. Some were a mixture of several varieties.

Table IV gives the yields of varieties added to the test for 1910.

Table V gives the average yield and tabular description of the bearded varieties in test three years. The varieties are arranged according to their rank of the average yield for three years.

Table VI gives the average yield and tabular description of the smooth varieties tested three years. The varieties are arranged according to their rank of the average yield for three years.

TABLE I—Yields of Varieties of Wheat, Tested for the Years 1899 to 1907 Inclusive.

Record Number.	Name of Variety.	Yield Per Acre—Bushels.								No. of Yrs. Tested.	Average Yield (bu.)
		1899	1900*	*1902	1903	1904	1905	1906	1907		
84	Fultz	34.0	41.3	29.8	15.5	20.2	32.3	25.4	41.8	8	30.0
95	Deitz	26.5	36.1	28 5	23.3	26.0	35.3	31.8	40.2	8	31.0
89	Currell's Prolific	41.1	37.4	38.7	20.8	26.8	32.8	30.5	40.7	8	33.6
92	Valley	26.5	41.5	27.3	17.3	27.7	32.5	29.3	37.7	8	30.0
103	Nigger	32.8	41.2	16.4	21.2	28.5	25.3	24.7	32.2	8	27.8
......	Turkish Red	......	32.0	15.5	......	......	......	......	......	2	23 8
105	Eclipse	......	38.6	28.7	21.2	29.7	22.6	28.0	......	6	28.1
109	Wyandotte Red	......	40.0	26.7	16.3	27.8	27.1	21.8	37.8	7	28.2
1930	Rocky Mountain	......	36.0	35.5	21.0	26.5	25.5	19.2	40.2	7	29.1
106	Australian	......	......	19.3	13.0	23.3	25.4	25.0	35 2	6	23.5
......	Hungarian	......	......	17.7	8.7	......	......	......	......	2	13.2
1733	Dawson's Golden Chaff	......	......	28.2	11.7	22.3	20.5	13.7	......	5	19 3
104	New Shanghai	......	......	......	.....	......	28.2	28.3	35.7	3	30 7

* No Data Was Taken in 1901.

TABLE II—Showing Comparative Yields of Varieties of Wheat Tested During the Years of 1908-09-10 Arranged According to the Average Yield of Grain for Three Years.

Record Number.	Name of Variety.	Weight Per Struck Bushel (Lbs.)			Corrected Yields of Grain Per Acre 60 Lbs. Per Bu.			Avg. Yield of Grain for 3 Years.	Corrected Yields of Straw Per Acre (Lbs.)		Avg. Yield of Straw for 2 Years.	Rank According to Yield of Grain.		
		1909	1910	Avg. for 2 Yrs.	1908	1909	1910		1909	1910		1908	1909	1910
1911	Bearded Purple Straw	57.0	58.1	57.6	34.81	27.49	31.01	31.10	4391	3852	4122	3	2	12
1981	Deitz Longberry	55.0	55.0	55.0	31.21	28.47	31.59	30.42	4141	4357	4249	31	1	6
194	China	55.0	57.4	56.2	35.63	23.36	31.54	30.18	3875	4205	4040	2	7	8
195	Turkish Amber	54.6	57.0	55.8	32.73	25.50	31.23	29.82	4021	3949	3985	14	5	11
89	Currell's Prolific	52.7	57.5	55.1	34.32	22.41	31.55	29.39	3896	3665	3781	4	10	7
1783	Dawson's Golden Chaff	50.5	53.3	51.9	34.21	19.59	34.01	29.27	3015	3523	3269	32	25	1
95	Deitz	58.3	58.2	58.3	32.49	26.15	28.88	29.17	4004	3850	3927	18	4	23
2008	Mammoth Red	56.0	59.0	57.5	31.52	27.26	28.21	29.00	4495	3233	3864	28	3	31
2500	Bearded Velvet Chaff	55.7	55.0	55.4	37.61	18.31	30.60	28.84	3783	3127	3455	1	32	13
92	Valley	55.2	55.0	55.1	32.24	21.41	32.43	28.69	3956	3771	3864	21	14	3
1987	Gill	51.2	58.0	54.6	32.88	21.63	31.50	28.67	3924	3626	3775	10	12	9
193	Harvest King	52.0	56.6	54.3	32.85	20.58	32.29	28.54	3706	3367	3537	11	19	5
188	Royal Red Clawson	52.7	56.0	54.4	32.89	22.75	28.65	28.09	3616	3292	3454	9	8	25
1942	Bearded Winter Fife	52.6	57.3	54.9	33.63	20.02	29.20	27.62	3880	3599	3740	6	22	20
199	Gypsy	55.2	56.4	55.8	32.96	19.10	30.53	27.53	3962	3739	3851	8	26	14
1912	Blue Stem	52.7	55.0	53.9	32.35	19.78	30.37	27.50	3998	3579	3789	20	24	17
1945	Lancaster Red	57.4	56.3	56.9	32.04	25.01	24.28	27.11	4080	3479	3780	25	6	53
1933	Jones' Winter Fife	53.9	55.0	54.5	33.66	17.21	30.41	27.09	3770	3475	3623	5	39	15
2191	(Not Named.)	53.2	57.4	55.3	29.92	22.41	28.58	26.97	3556	3517	3537	41	11	27
1915	Purple Straw	58.3	56.1	57.2	29.90	22.59	27.16	26.55	4325	3143	3734	42	9	37
1980	Fultzo-Mediterranean	52.5	57.2	54.9	32.39	18.84	28.32	26.52	3726	3145	3436	19	28	29
1925	Mealy	52.1	51.5	51.8	31.91	14.58	32.88	26.46	3536	3873	3705	27	54	2
1744	Red Early Genesee Giant	54.0	54.5	54.3	29.68	18.04	31.50	26.41	3645	3823	3734	45	35	10

1941	Diamond Grit	58.2	57.3	57.8	32.82	18.27	27.89	26.33	3878	3563	3721	12	33	33
1934	Swamp	53.2	56.4	54.8	31.97	20.39	26.25	26.20	2724	3557	3141	26	20	43
1930	Rocky Mountain	55.5	54.3	54.9	30.36	19.91	28.28	26.18	4104	3387	3746	38	23	30
84	Fultz	51.4	54.4	52.9	30.75	18.01	29.66	26.14	3700	3807	3754	34	36	18
1745	Reith	49.1	53.8	51.5	32.75	16.54	28.98	26.09	3449	3451	3450	13	47	21
198	Poole	48.7	52.0	50.4	32.60	16.75	28.89	26.08	3256	3207	3232	15	45	22
191	Rural New Yorker	53.1	58.0	55.6	32.15	18.36	27.74	26.08	3202	3743	3473	22	30	35
1974	Martin's Amber	57.1	57.1	57.1	28.93	16.87	32.37	26.06	3782	3737	3760	50	43	4
1972	Beechwood Hybrid	51.8	52.5	52.2	31.41	16.95	29.79	26.05	3598	4295	3947	29	41	19
2498	Jones' Early Red Chaff	49.3	52.5	50.9	28.28	21.15	28.61	26.01	3394	2837	3116	53	16	26
1973	New Amber Longberry	53.7	58.8	56.3	29.34	18.15	30.37	25.95	3080	3856	3468	48	34	16
1909	Mediterranean	52.3	56.5	54.4	30.67	20.15	26.70	25.84	3988	4019	4004	35	21	41
1732	Fish-Head	55.8	54.8	55.3	30.82	21.27	25.28	25.79	3324	2546	2935	33	15	49
105	Eclipse	50.0	53.4	51.7	32.05	19.04	25.93	25.67	3839	3563	3701	24	27	44
1935	Spade	48.6	56.5	52.6	30.13	20.91	25.39	25.48	3802	3022	3402	40	18	47
189	Reliable	51.8	56.1	54.0	30.82	17.86	27.74	25.47	3476	3181	3329	30	37	34
1922	Early Red Clawson	50.3	54.0	52.2	29.42	17.68	28.06	25.05	4138	3992	4065	47	38	32
1979	Poole	47.8	55.8	51.8	33.35	15.77	25.52	24.88	2988	4149	3569	7	49	46
1937	Pride of Genesee	52.3	54.0	53.2	28.93	18.58	27.11	24.87	3764	3149	3457	51	29	38
2496	Jones' Silver Sheath Longberry	53.0	54.1	53.6	29.58	16.45	28.42	24.82	3496	3675	3586	46	48	28
1747	Canadian Hybrid	51.8	56.0	53.9	30.56	16.58	26.97	24.70	3100	3353	3227	36	46	39
1993	Boughton	49.2	51.5	50.4	32.07	16.77	24.99	24.61	3883	3909	3896	23	44	51
1960	Cox	54.5	55.8	55.2	30.49	16.96	26.37	24.61	3643	2889	3266	37	40	42
1984	Tuscan Island	51.0	55.2	53.1	28.30	21.45	23.22	24.32	3623	2785	3204	52	13	55
2007	Frost Proof May	54.0	59.0	56.5	22.42	20.95	28.78	24.05	3844	3891	3868	57	17	24
1969	Michigan Amber	57.2	53.0	55.1	29.85	14.85	27.32	24.01	3796	3897	3847	44	52	36
1673	Servia	52.2	55.0	53.6	29.87	16.89	25.16	23.97	3596	3853	3725	43	42	50
1910	Blue Stem	48.6	55.0	51.8	32.58	15.04	23.70	23.77	2812	3255	3034	16	51	53
1739	Budapest	54.5	53.2	53.9	29.20	15.18	26.80	23.72	3413	3163	3288	55	50	40
1757	Japanese Velvet Chaff	52.2	53.1	52.7	30.28	13.15	24.79	22.74	3253	3552	3403	39	56	52
1975	Velvet Red Giant	49.4	55.0	52.2	27.99	14.14	25.81	22.65	3062	2875	2969	54	55	45
1695	Onigara	53.0	51.3	52.2	29.22	18.34	18.19	21.91	2670	1887	2279	49	31	57
1505	(Not Named)	57.0	53.2	55.1	32.50	12.15	18.65	21.10	2532	3413	2973	17	57	56
1782	Turkey	49.5	55.0	52.3	22.91	14.76	25.36	21.01	3188	2879	3034	56	53	48
1951*	Extra Early Oakley	51.6	57.5	54.6	......	22.41	25.97	......	3696	2883	3290	.....	.....	.....
227*	Skipper	49.6	57.4	53.5	......	21.61	24.32	......	3944	4389	4167	.....	.....	.....
1449*	Maryland Flint	52.3	.....	.....	25.69	18.95	......	......	3884	.....	.....	.....	.....	.....
1749*	Early Arcadian	44.4	.....	.....	25.95	7.92	......	......	3004	.....	.....	.....	.....	.....

* In Test Two Years Only.

TABLE III—Showing Yields of Varieties of Wheat Tested in 1908—Discarded After One Year's Test.

Record Number.	Name of Variety.	Corrected Yield of Grain Per Acre, 60 Lbs. Per Bu.
196	Rudy	21.24
1752	Gold Coin	28.01
192	Jones' Longberry Red No. 1	25.15
120	Councilman	27.97
122	Councilman	28.36
109	Wyandotte Red	28.08
1432	Crimean	24.49
1989	Clawson	24.07
1754	Wellman's Fife	22.08
1931	Everitt's High Grade	27.95
1958	Zimmerman	27.62
1761	Soft White	16.88
115	Councilman	26.91
1983	Jones' Longberry No. 1	27.68
1557	Carman No. 1	24.88
1697	Early Bart	25.02
1734	Long Head	14.18
2497	New York	25.86
1586	Berdiansk	14.80
1997	Moldavian	27.27
1728	Rice	24.45
2185	Taganrog	21.51
2453	Early Japanese	16.31
1952	Red May	26.00
2163	Bearded Pootung	16.76
1926	Sea Island	5.62*

* Tested in 1909.

TABLE IV—Showing Yields of New Varieties of Wheat Added to the Test for 1910.

Record Number.	Name of Variety.	Weight Per Struck Bushel.	Corrected Yield of Grain Per Acre (Bu.)	Corrected Yield of Straw Per Acre (Lbs.)
347	New York No. 10	57.0	27.78	3046
348	Doub	59.4	26.97	3321
349	Rudy	53.0	27.95	3480
350	Early Red Chief	53.0	29.32	3430

TABLE V—Showing Average Yield and Tabular Description of the Bearded Varieties in Test Three Years.

Record Number.	Name of Variety.	Height of Plant at Harvest Time Ft., and In.	Stiffness of Straw in %	Date of Ripening.	Color of Grain.	Average Yield of Grain for 3 Yrs.
1911	Bearded Purple Straw...........	4-3	94	6-20	Red	31.10
1981	Deitz Longberry	3-9	93	6-21	Red	30.42
195	Turkish Amber..................	4-2	92	6-22	Red	29.82
95	Deitz..........................	4-1	96	6-20	Red	29.17
2008	Mammoth Red..................	4-2	88	6-22	Red	29.00
2500	Bearded Velvet Chaff	3-5	97	6-24	White to Amber	28.84
92	Valley	4-2	94	6-22	Red	28.69
1942	Bearded Winter Fife............	3-11	94	6-23	White to Amber	27.62
199	Gypsy.........................	3-9	94	6-23	Red	27.53
1912	Blue Stem......................	3-11	95	6-23	Red	27.50
1945	Lancaster Red..................	4-2	90	6-21	Red	27.11
1933	Jones' Winter Fife..............	3-11	95	6-24	Red	27.09
1744	Red Early Genesee Giant........	3-11	97	6-23	White	26.41
1941	Diamond Grit....................	4-1	93	6-25	Red	26.33
1934	Swamp.........................	4-0	97	6-24	Red	26.20
1930	Rocky Mountain................	4-1	93	6-23	Red	26.18
1745	Reith...........................	3-11	97	6-23	Red	26.09
191	Rural New Yorker........... ..	4-2	97	6-23	Red	26.08
2498	Jones' Early Red Chaff..........	4-0	95	6-23	Red	26.01
1973	New Amber Longberry..........	4-4	95	6-24	White	25.95
1909	Mediterranean	4-1	96	6-20	Red	25.84
1732	Fish-Head.......................	3-10	96	6-21	Red	25.79
105	Eclipse.........................	3-10	96	6-23	Red	25.67
1935	Spade..........................	3-10	95	6-23	Red	25.48
189	Reliable..................... ..	4-0	95	6-21	Red	25.47
1937	Pride of Genesee...............	4-	93	6-23	Red	24.87
2496	Jones' Silver Sheath Longberry.	3-11	92	6-21	Red	24.82
1960	Cox............................	4-0	98	6-22	Red	24.61
1984	Tuscan Island..................	4-2	92	6-21	Red	24.32
1673	Servia	3-9	95	6-24	Red	23.97
1910	Blue Stem	4-0	95	6-24	Red	23.77
1739	Budapest.......................	3-9	94	6-22	Red	23.72
1757	Japanese Velvet Chaff...........	3-10	95	6-23	Red	22.74
1975	Velvet Red Giant	3-11	98	6-21	Red	22.65
1695	Onigara........................	3-6	90	6-21	Red	21.91
1782	Turkey	3-11	88	6-20	Red	21.01

TABLE VI—Showing Average Yield and Tabular Description of the Smooth Varieties Tested Three Years.

Record Number.	Name of Variety.	Height of Plant at Harvest Time Ft., and In.	Stiffness of Straw in %	Date of Ripening.	Color of Grain.	Average Yield of Grain for 3 Yrs.
194	China	4-1	95	6-24	Red	30.18
89	Currell's Prolific	4-1	97	6-21	Red	29.39
1733	Dawson's Golden Chaff	3-10	97	6-23	White	29.27
1987	Gill	3-10	92	6-21	Red	28.67
193	Harvest King	4-0	94	6-23	Red	28.54
188	Royal Red Clawson	3-11	95	6-22	Red	28.09
2191	Wheat	3-9	97	6-23	Red	26.97
1915	Purple Straw	3-10	92	6-23	Red	26.55
1980	Fultzo-Mediterranean	3-10	98	6-21	Red	26.52
1925	Mealy	3-11	96	6-22	Red	26.46
84	Fultz	4-1	95	6-19	Yellow	26.14
198	Poole	4-1	93	6-22	Red	26.08
1974	Martin's Amber	3-11	95	6-26	White to Amber	26.06
1972	Beechwood Hybrid	4-1	93	6-21	Red	26.05
1922	Early Red Clawson	3-11	99	6-20	Red	25.05
1979	Poole	3-10	95	6-19	Red	24.88
1747	Canadian Hybrid	3-11	97	6-24	Red	24.70
1993	Boughton	4-2	96	6-21	Red	24.61
2007	Frost Proof May	4-1	92	6-21	Red	24.05
1969	Michigan Amber	4-1	98	6-21	Red	24.01
1505	(Not Named)	3-11	99	6-24	Red	21.10

WHEAT SMUTS.

Smuts are parasitic and belong to a class of plants known as fungi. There are two kinds of smut, the loose and stinking smut, or bunt. Loose smut is quite common over the state, some years worse than others. Careful counts the past two seasons showed that the loss to be from a trace to 10 per cent. One-half to two per cent. is the most common. This smut appears to be worse on sandy than clay soils. Stinking smut has not been so general but in some localities as much as 15 per cent. damage has been reported this year and a loss in price of seven to eight cents per bushel. The two smuts can be easily distinguished from each other as will be noted from the following description:

LOOSE SMUT.

Description:—The first appearance of loose smut to the farmer is at the time of heading. Smutted heads are usually among the first to appear, although the maximum amount is generally seen just before full bloom. As both the grain and chaff are attacked by this smut, the whole head is usually transformed into a mass of smut spores nearly coal-black in color. These spores correspond in function to the seed ot higher plants. Soon after the head is exposed to the air the black, powdery mass (spores) is set free and blown about by the wind, leaving only the rhachis or stem of the head which is never destroyed and is all that can be seen at harvest time.

The life history of loose smut may briefly be stated as follows: As soon as the smutted head is exposed to the air, spores are scattered all over the field. They are blown by the wind into the spikelets where they finally find their way to the stigma or young ovary. Here they germinate and, penetrating the embryo, develop in the grain until it ripens, without producing spores. There is nothing about the external appearance of the grain to indicate that it is infested with the smut fungus. After ripening of the grain the filaments of the fungus lie dormant until the grain is planted and germinates in the soil. Then the fungus continues to develop in the plant along with the growing point until the head is formed, when it infests the young grains and chaff, destroying and replacing them with masses of the smut spores to be blown again over the field.

STINKING SMUT.

Description:—In the stinking smut of wheat the grain only is affected and changed into a mass or ball of smut spores. The chaff is seldom, if ever, destroyed, so that close inspection is necessary to distinguish smutted from healthy heads. The smutted grains are more irregular, usually larger, and are more easily broken than normal kernels. When the smutted grain is broken, a characteristic odor is given off, hence the name.

The life history differs from the loose smut in that the spores are not scattered by wind at flowering time, and then start growing in the young grain, but in the threshing and other handling of the seed are distributed, and adhering to the grain, are planted with it and germinate at the same time. The fungus then penetrates the young plant somewhere below the soil, grows along within it to the blooming period when it invades the young grains. Here it further develops inside the grain hull, and matures its masses of spores to be again distributed at threshing and other handling of the grain.

Infection by distribution in adjacent fields is very slight. It seems to be necessary for the spores to be in the right spot to come in contact with the wheat grain and to germinate at essentially the same time, or there will be no infection. One-half bushel of smut balls distributed by the North Dakota Station on one square rod was not sufficient to materially increase the amount of smut in the succeeding crop.

TREATMENT OF SMUTS.

There are many methods of treating smuts, most of which are reasonably successful. In this bulletin, not all, but only a few of the best and most simple methods will be given.

Treatment for loose smut:—Since this fungus is carried over from crop to crop by internal (not external) infection of the grain, the ordinary fungicides are not effective. The most effective method of prevention thus far known for this smut is Jensen's modified hot-water treatment. This treatment has been tested by a number of Experiment Stations with varying results. The treatment has been varied from one extreme to another as to the time of soaking the grain before immersing it in hot water, the time of leaving it in the hot water, and the time of leaving it soak after immersing. The temperature of the water has been varied in the same way. The results have not always been the same at the different Stations, when the treatments were the same. All investigations, however, show that the best results are obtained within comparatively narrow limits of temperature and time of immersing the seed in hot water. Freeman and Johnson, of the United States Department of Agriculture, from extensive investigation, found that "soaking the grain from five to seven hours in cold water, followed by immersion in hot water at 129.2 degrees F. (54 degrees C.) for ten minutes" gave the best results. The treatment of the grain slightly decreased the germination, but practically freed the resulting crop from smut. When tried on a large scale in a practical way, equally good results were obtained. No doubt the effectiveness of this treatment is due in a large measure to the long soaking of the grain in cold water before immersion in the hot water. Those undertaking this treatment should watch the temperature very closely, and keep it at 129 to 130 degrees F. The range of temperature between which the smut fungus is killed and germination of the seed uninjured is very narrow. The time of the immersion of the seed should not vary more than a few seconds. After the seed has been immersed, it should be spread out about one inch deep to dry, after which it can be resacked and used when needed.

It is evident that in order to use this method on a large scale, special equipment is necessary. Only large growers can afford this, but every farmer with ordinary kitchen and wash-house equipment can treat a small amount of seed and plant this in a seed plat by itself to be used for general seeding the following year. The seed plat should be isolated and not placed next to smutted fields of the same crop. The smut spores are carried by wind for long distances.

Treating small quantities of seed:—Always start with clean seed and soak it from five to seven hours in ordinary cold water. Then place it in a loosely woven sack, wire basket, or other perforated vessel holding about a peck, and allow it to drain for a short time. Now have two tubs or wash-boilers full of water heated up to 129 or 130 degrees F. Number the tubs one and two. Place the drained baskets or sacks of seed in tub No. 1 for a minute or two, then immerse in tub No. 2

for ten minutes and keep agitating. The object of tub No. 1 is to bring the grain up to the desired temperature so that it will not lower the temperature in tub No. 2. If the grain is placed in sacks, they should be larger than is necessary to hold it and tied at the end so that a churning motion can be set up in agitating. If the temperature is allowed to fall below 129 or rise above 130 degrees F., the time of immersion must be lengthened or shortened accordingly. Under no circumstances, however, should the temperature be allowed to rise above 132 degrees F. or below 124 degrees F. A temperature above 132 degrees F. is injurious to the seed, and below 124 degrees F. is not effective. Oil or gasoline stoves are valuable aids for holding a uniform temperature.

After the seed has been treated it may be spread out to dry or planted while damp. When planted while damp allowance must be made for the swelling. The germination of the seed is always lowered somewhat by this treatment. Under the most careful handling, it is only slight, but on the average, about 25 per cent. more seed should be planted than when the grain is untreated.

TREATMENT OF STINKING SMUT.

Formalin:—The most simple method of preventing this smut is the formalin treatment. This consists of wetting the grain with a solution of formalin, made by dissolving one pound of ordinary commercial formalin in forty or fifty gallons of water. The grain can be dipped in the solution or wetted by sprinkling or spraying with a spray pump. In either case the object is to thoroughly wet every grain. The efficiency of the treatment depends on this. If the grain is dipped, it should be allowed to remain in the solution for ten or fifteen minutes. In dipping, the grain should be placed in wire baskets or in loose burlap sacks partly filled and tied at the end so that the seed can be churned about to insure every grain getting thoroughly wet. After immersion the grain should be allowed to drain for a few moments and then spread out to dry. After thoroughly drying, it may be sacked up and kept until wanted. It may also be planted while still damp, but in this case, allowance must be made for the swelling.

When sprinkling the seed, it should be spread out thinly over a floor and the solution applied with a sprinkling can or with a spray pump throwing a fine spray. While the solution is being applied, the grain should be stirred constantly with a hoe, shovel or garden rake. About three quarts of the solution to the bushel will be required. After the grain is thoroughly wet, it may be put in a pile and covered with old sacks or canvas, and allowed to remain this way for an hour or two, then it should be spread out to dry.

The Copper Sulphate Treatment (sometimes called "blue stone" or "blue vitrol") is one of the oldest methods used for preventing smut. Solutions of many different strengths have been used successfully. As is the case with formalin, the seed may either be dipped or wetted by sprinkling. When the seed is dipped, two pounds of copper sulphate to fifty gallons of water are used. Soak the seed in this solution for twelve hours, stirring now and then. After soaking place the grain for a few minutes in lime water made by using one pound of quick lime to ten gallons of water. When the grain is taken from the lime water it can be spread out to dry, sacked and used when needed.

Another method is to dissolve one pound of copper sulphate to four gallons of water. Apply the solution by sprinkling or with a spray pump, mixing the seed constantly while the solution is being applied until every grain is uniformally wet, then spread out to dry. Air-slacked lime may be mixed with the seed to facilitate drying. Copper sulphate is slightly injurious to the germination of the seed, and about one gallon more seed per acre should be planted of the treated than of the untreated seed.

Corrosive Sublimate:—This treatment was developed by Bolley, of the North Dakota Station, and has been found very effective for stinking smut of wheat. The formula is one pound of corrosive sublimate ($HgCl_2$) to fifty gallons of water. Wet uniformally by spraying with the solution or by dipping as recommended for the copper sulphate treatment. After the grain is thoroughly wet, it should be dried.

Corrosive sublimate is poisonous, and the grain after being treated will kill chickens and other live stock. Seed treated with copper sulphate and formalin is not poisonous to stock. All of these chemicals may be purchased in any drug store.

WHEAT SCAB.

This trouble while common over the state of Maryland is usually worse in the Costal plain than in the Piedmont and mountain sections. It is always worse in years when the weather is wet, hot and muggy at the time wheat is heading or the seed is forming. So striking is this that the writer has often been informed by farmers that they would have had a heavy crop of wheat had it not been for the wet weather and heavy dews at the time wheat was in bloom, which, as they thought, washed away the pollen before fertilization took place. During the past season the writer examined many fields in all sections of the state and found scab in all of them. It is safe to say that this year, although generally considered a good wheat year, the damage due to scabs has cut the yield at the lowest estimate 10 per cent. In bad wheat years the damage may amount to 25 per cent. or more. The writer has watched many fields which up to the time of blooming gave every promise of 35 or 40 bushels per acre, but when threshed yielded less than 20 bushels of badly shriveled grain.

While not much is known concerning this trouble, enough has been discovered, however, to make it fairly certain that it is caused by one or more specific diseases. Selby and Manns give *Fusarium roseum and Gibberella Saubinetii* as causing this trouble.

Septoria glumarum was also discovered by Miss Vera K. Charles of the United States Department of Agriculture on samples of many of the varieties grown at this Station, and also on samples collected over this state. This is said to cause considerable damage in sections of Italy. There is no remedy for scab as far as treating the seed is concerned, although treating with formalin is said to lessen the damage somewhat. The only relief will be found in growing the varieties most resistant to this disease or diseases. There is a wide range of difference between varieties as to their ability to withstand the attacks of scabs. One of the principal reasons why some varieties yield so exceptionally high one year and low the next, is because in years when conditions are favorable for scab development they become badly infested. The highest yielding varieties tested by this Station the last three years were among those least affected by scab.

In general it may be said that smooth varieties scab worse than bearded ones. In both the bearded and smooth varieties the velvet chaff sorts scab the worst.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

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SPRAYING, FUMIGATING AND DIPPING FOR THE CONTROL OF SAN JOSE SCALE.

By T. B. Symons, L. M. Peairs and E. N. Cory.

INTRODUCTION.

Notwithstanding the educational campaign that has been carried on in this state during the past ten years through the presentation of bulletins, the inspection of orchards and nurseries, demonstration sprayings, the operation of public sprayers and the effective and practical work of progressive orchardists in the control of the San Jose Scale, there still remains a large per cent of farmers who do not know the pest, and who take no steps to control it. Consequently a large number of orchards, more especially the small ones, are being seriously injured by its ravages. This condition prevails largely in those counties where fruit growing is not a prominent source of income to the farmers. Ocharding is greatly on the increase in Maryland, and, as a consequence, there are many engaging in the business who are not familiar with this and other insect pests that may prove a severe barrier to their success in the business.

There is still much demand for information as to the nature of the San Jose Scale, and as the former bulletins giving the description and life history have been exhausted, the matter will be repeated in this bulletin.

As stated in previous bulletins of this Station, the San Jose Scale is no longer feared by the progressive orchardists. They have demonstrated to their own satisfaction that they can control it by the use of insecticides. They recognize, however, that it necessitates an annual warfare and they are constantly seeking the best remedy, all aspects considered, that may appear on the market. For this reason it has been advisable to continue the spraying experiments, testing the various remedies as they appear on the market, in order to answer intelligently inquiries concerning them. The result of the past year's work is herewith given.

Previous investigations at this and other stations have not given conclusive results in regard to the dipping of nursery trees in insecticides as a substitute for fumigation with hydrocyanic acid gas or additional treatment to prevent the distribution of San Jose Scale on such stock. Inasmuch as there seemed a demand for accurate information concerning this treatment, a series of experiments were conducted in the fall of 1909 and spring of this year in an endeavor to arrive at more definite conclusions than were secured in the tests conducted in 1908.

The results of a limited test in fumigation of peach buds in the nursery with hydrocyanic acid gas and a brief discussion of the Osage Hedge menace are given, as each subject, although discussed in former bulletins remains an important economic problem in the State.

There continues to exist in this State a wide field for conducting demonstration work. A discussion of different phases of this character of work is given in this bulletin.

GENERAL DESCRIPTION OF SAN JOSE SCALE.

A tree when badly infested with the San Jose Scale presents a somewhat grayish appearance as if it were coated with ashes, but to the ordinary observer the tree would hardly seem to be infested unless very closely examined. However, if one should attempt to scrape the bark it would be seen to be covered with numerous little scales of varying sizes, beneath which lie the small, oval, orange colored, jelly-like objects which are the true insects. If the examination should be made in the summer time the yellowish young lice would be seen crawling about over the scales seeking a place to insert their beaks. Fig. 1 illustrates the appearance of this insect on the bark of an apple twig. The presence of scale on a tree is readily detected by examining the fruit. Surrounding each scale, especially when located on fruit, is a bright red blotch caused either by the effect of secretions of the insects in-

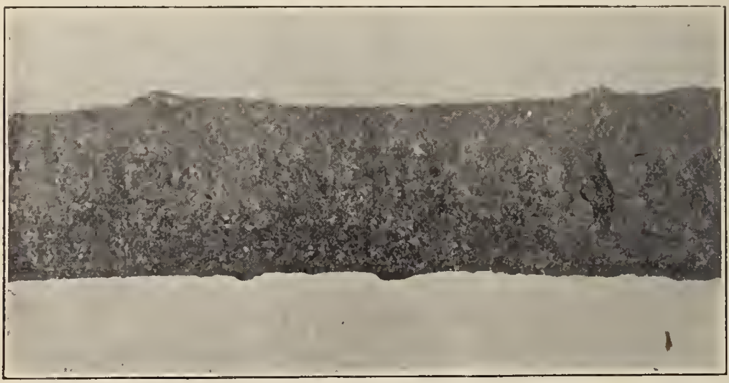

Fig. 1.—San Jose Scale on apple twig. (Cory.)

jected through its beak into the tissues, or by a change in the epidermal cells, brought about by the irritation of the setae in the tissues. When on fruit, the insects seem to be more thickly distributed around the calyx in apples and pears, (see Fig. 2) while on peach they are more numerous at the stem end. In examining fruit, especially pears, one must be careful not to attribute a spot caused by the pear leaf blight to a scale insect. The scale can always be distinguished by lifting the cover or scale from the insect. It is easier to observe the scale on the smooth bark of the twigs than on the trunks and branches for there as on the fruit, they are usually surrounded by bright red blotches, which extend below the bark into the wood. On badly infested trees the scale will also be seen on the leaves, usually in clusters along the mid-rib and veins.

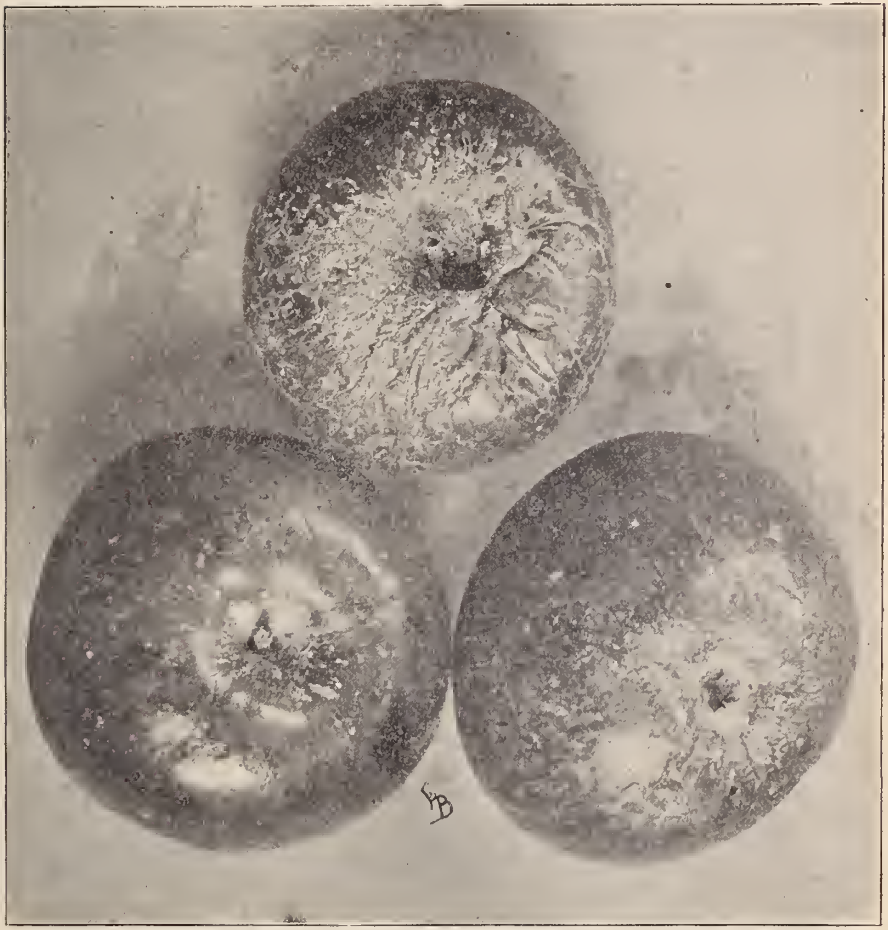

Fig. 2.—Apples badly infested with San Jose Scale. (Blodgett.)

If an adult female insect is closely examined, a small grayish circular scale about one-twenty-fourth of an inch in diameter, the center of which is convex forming a slight nipple will be seen; also numerous concentric circles can be seen around the nipple the scale developing by additions to the outer edge. The scale of the male is somewhat elongated. Beneath the scale is the true jelly-like individual. The color of the scale is variable. In the half mature insect the scale is nearly black with a central gray nipple and one or two grayish rings, but it gradually becomes entirely grayish when approaching the adult state.

Life History.

The life history of the San Jose Scale differs from most insects of this class, as it winters as a partially mature insect under the scale. Early in the spring it begins to develop, and about the first of May, in this latitude, the adult male emerges from beneath the scale as a minute winged insect. The female reaches maturity about a month later and begins to produce its young soon afterwards. The female lays no eggs but brings forth living young. The period of reproduction of a female extends over about six weeks and her progeny in that time will number about 400. The young insects are extremely small, yellowish in color and resemble small mites. They have six legs, a pair of antennae and a long thread-like beak through which they extract the juices from the plants. They crawl around on the surface on which they happen to be for twelve to twenty-four hours in search of a suitable place to insert their beaks and, if females, remain there the rest of their lives. In about a month from the date of birth, the young scale insects reach maturity and the females then commence to reproduce. There are about four generations during a season in this latitude. The insect thus increases very rapidly where no effort is made to hold it in check.

Means of Distribution.

Although the young of the San Jose Scale are so tiny and are only able to crawl around on the infested tree for a period extending over about twenty-four hours and cannot of themselves reach other trees, yet it is evident that the insect is distributed from tree to tree and from orchard to orchard. This is accomplished by many outside agencies: first, it may be distributed on nursery trees, however, this means is protected against by law; second, by wind which in blowing over an infested orchard may carry some of the young larvæ on numerous particles which it twirls along to other trees in the vicinity; third, birds and various insects are responsible for carrying the scale, sometimes long distances, on their feet and bodies. There is also some danger of the larvae being carried by men and domestic animals in going through an infested orchard. It is likely that they hit the branches of some of the trees and in this way are the means of transporting the larvae from tree to tree. Thus, while the San Jose Scale is unable to distribute itself, there are many agencies through which dissemination is possible.

MEANS OF CONTROL.

As this insect does its injury by sucking the juices of the trees a contact insecticide is employed in its control. After several years of experimentation by scientists and orchardists two general classes of contact insecticides are accepted as efficient remedies, viz: the lime-sulfur wash and miscible oils. The former is generally accepted as the more satisfactory, not only on account of its greater range and adaptability to all kinds of trees, but also its safeness, inexpensiveness and fungicidal properties. While many of the miscible oils are efficient and are somewhat more easily applied yet from experience in this State they cannot be considered as an entirely safe treatment for peach.

The lime-sulfur remedy was originally a home made wash, but of late years a manufactured product has been placed on the market. There has thus been considerable rivalry between manufacturers of both classes of remedies and it has been the aim of this department to test the different brands as they appear on the market, so that definite advice could be given concerning them.

SPRAYING EXPERIMENTS.

There were twenty different spray mixtures tested the past year. Both fall and spring applications were made of seven solutions on apple trees and the additional ones were sprayed on adjoining trees of the same orchard in the spring. Some of the solutions applied in the spring were not available for fall treatment. The tests were made in the orchard of Mr. L. A. Stauffer, Locost Grove, Kent County. The trees were eleven years old, but in poor condition, due to the ravages of the scale. All the trees were for the most part encrusted with the pest. This orchard furnished an excellent opportunity to study the relative efficiency of lime-sulfur and oil sprays. About three hundred and fifty trees were sprayed in this orchard.

Unfortunately at the time of application of most of the solutions used on this orchard, November 26, 1909, the weather was very unfavorable being windy and changeable, consequently the spraying could not be as thorough as was desired.

Additional tests were conducted in the spring on peach trees in the orchard of Chas. W. Keller, located on South Mountain near Harper's Ferry. This orchard contains about twenty thousand peach trees. About seven hundred large trees which were badly infested were selected for the experiment. In addition to applying all the solutions used on apple and two new oil products, the home made concentrated lime-sulfur solution was applied. This gave an opportunity to compare the efficiency of this home made product with the manufactured lime-sulfur compounds. The tests in this orchard were applied March 21 and 23, the weather at the time was ideal for spraying.

The thanks of the department are extended to Messrs. J. A. Stauffer and C. W. Keller for the loan of their orchards for the tests and the cordial assistance rendered in conducting the work.

The following is a list of the tests made and a brief statement of the results obtained with the various solutions employed:

Lime-Sulfur Mixtures.

HOME MADE LIME-SULFUR.

The regular home made lime-sulfur wash formula, 20 pounds of lime, 15 pounds of sulfur to 50 gallons of water boiled forty minutes, was applied on fifteen apple trees December 3, 1909, and on 27 apple trees March 18, 1910, in the Stauffer orchard, and on a few small apple trees and 50 large peach trees in the Keller orchard March 21, 1910. In all cases it maintained its usual efficiency. This was included in the tests as a basis of comparison for the other washes.

HOME MADE CONCENTRATED LIME-SULFUR.

As the name indicates this is a concentrated lime-sulfur wash, made by boiling 125 pounds of sulfur with 60 pounds of lime, making a barrel of concentrate solution which tested 27° Beaumé. It was applied at the rate of one to seven on thirty-five peach trees in the Keller orchard March 21, 1910. A full discussion of this solution and method of preparation is given elsewhere in this bulletin. It is sufficient to say that the results from this wash compared favorably with those of any lime-sulfur preparation used.

ORCHARD BRAND LIME-SULFUR.

A liquid lime-sulfur preparation, manufactured by the Thomsen Chemical Company, Baltimore, Maryland. This solution was applied on thirty-two apple trees in the Stauffer orchard November 27, 1909 and on eighteen apple trees March 18, 1910, and on thirty-five peach trees at Harper's Ferry, March 21, 1910. In all cases it was diluted at the rate of one part of the solution to nine parts of water. Some scale was found on both fall and spring treatment on apple trees in Kent County, Maryland. It, however, compared favorably with the most efficient treatment on these badly infested apple trees. In the spring tests in the Keller orchard results were excellent.

GRASSELLI'S LIME SULFUR.

A concentrated lime-sulfur wash manufactured by The Graselli Chemical Company, Cleveland, Ohio. This solution was sprayed on sixteen apple trees in the Stauffer orchard December 3, 1909, and on thirty apple trees March 18, 1910, at the rate of one to nine. It was not applied on peach. The results indicated that it was as good as the other lime-sulfur washes.

SHERWIN-WILLIAMS LIME-SULFUR.

A similar concentrated lime-sulfur wash manufactured by Sherwin-Williams Company, Newark, New Jersey. Sprayed on sixteen apple trees in the Stauffer orchard March 18, 1910. Also on thirty-five peach trees in the Keller orchard March 23, 1910. The strength used was one to nine. Results compare very favorably with other spring treatments of lime-sulfur.

BOGART'S SULFUR COMPOUND.

A sulfur compound liquid spray, manufactured by W. H. Bogart, 24 Grove Street, New York. It was applied on twenty-four apple trees in the Stauffer orchard March 18, 1910, at the rate of one to fifteen, and on thirty-five peach trees at Harper's Ferry, March 21, 1910, at similar strength. This solution proved as effective as any lime-sulfur applied on apple trees, and compared favorably with others on peach.

LION BRAND LIME-SULFUR.

A concentrated lime-sulfur, manufactured by the James C. Blanchard Company, 30 Church Street, New York. Twenty-four apple trees in the Stauffer orchard were sprayed March 17, 1910. This solution was applied at the rate of one to nine. The spray seemed to give good results and compared favorably with others. The results on forty-six peach trees sprayed March 23, were entirely satisfactory.

REX LIME-SULFUR.

This is one of the first concentrated lime-sulfur mixtures that appeared on the market. We have found this brand satisfactory in former tests. It was included in the spring tests, March 21, 1910, on thirty-five peach trees in the Keller orchard, principally for comparison with other brands. It was applied at the rate of one to nine, and proved equally as efficient, as previously reported, being excelled by none.

NEVER-SCALE.

This is a powdered lime and sulfur compound manufactured by the Sulfo-Chemical Company, of Philadelphia, Pennsylvania. The material is prepared for use by boiling in a small quantity of water for about five minutes. Thirty apple trees were sprayed March 18, 1910, in the Stauffer orchard with this solution at the rate of one pound to 1 gallon of water. The results were excellent, comparing favorably with the rest. Also twenty-four peach trees were treated March 23d in the Keller orchard. The results on peach trees were equally as good as on apple.

VREELAND'S LIME-SULFUR.

A concentrated lime-sulfur solution put up by the Vreeland Chemical Company, 50 Church Street, New York. Thirty-five peach trees in the Keller orchard were treated with this preparation at the rate of one to nine March 23, 1910. This was the first test of this brand and it showed to be as efficient as the best lime-sulfur solutions.

SCALIME.

A liquid lime-sulfur solution manufactured by the Chester County Chemical Company, West Chester, Pennsylvania. Four apple trees were treated with this preparation at the rate of one to nine, November 26, 1909. There was no spring test of this solution in this orchard. The results here were good considering the conditions. Thirty-five peach trees were sprayed with scalime in the Keller orchard March 23, at the rate of one to nine. The results were satisfactory.

NIAGARA BRAND LIME SULFUR.

A concentrated lime-sulfur solution manufactured by the Niagara Sprayer Company, Middleport, New York. Sprayed on twenty peach trees in the Keller orchard at the rate of one to nine, March 23, 1910. Results were satisfactory. Equal to other lime-sulfur washes.

Oil Mixtures.

ORCHARD BRAND SOLUBLE OIL.

A miscible oil manufactured by the Thomsen Chemical Company, Baltimore, Maryland. This solution was used fall and spring, on apple and peach at the rate of one to fifteen, in the Stauffer orchard. Sixteen apple trees were treated in fall and nine in the spring, November 26, 1909 and March 17, 1910, respectively. Thirty-five peach trees were sprayed March 23, 1910, in the Keller orchard. The results from this wash were good in each case. There was an apparent advantage in the spring application over lime-sulfur compounds, and over the fall application of the same oil on apple trees.

SCALECLEAN.

A new soluble oil preparation made by J. A. Cocklin, Siddonsburg, Pennsylvania. This solution was only tested on peach trees in the Keller orchard. Thirty-five trees were sprayed at the rate of one to fifteen, March 21, 1910. The results of this wash showed thirty trees of the test to be in good condition, no live scale being found, while on two trees scale was breeding. As there may have been an accident at the time of application or distribution from check trees it would seem that the solution can be classed with the other soluble oil preparations as giving good results.

SCALEOIL.

A miscible oil manufactured by the Chester County Chemical Company, West Chester, Pennsylvania. A new oil spray that readily mixes with water. Sprayed on ten apple trees in the fall at the rate of one to fifteen. It showed to be moderately effective in this test; trees did not show as good as those sprayed with the preceding solution. Also thirty-three peach trees were sprayed March 21, 1910, at the rate of one to fifteen. The results of this test were satisfactory being as good as any others.

SCALECIDE.

A miscible oil manufactured by the B. G. Pratt Company, 50 Church Street, New York. This remedy has been on the market for some time. It was sprayed on thirty-four peach trees March 21, 1910. at the rate of one to fifteen. It gave satisfactory results.

VACUUM OIL.

A petroleum oil emulsion made by the Standard Oil Company, Baltimore, Maryland. Twenty-two apple trees were sprayed November 26, 1909, at the rate of one to fifteen, and also eighteen trees in the same orchard were treated March 17, 1910, at a similar strength. The results from this oil were comparatively good on apple; the fall sprayed trees seemed more vigorous than those treated iin the spring. Thirty peach trees were sprayed with Vacuum Oil March 21, 1910, at the rate of one to fifteen. The results on peach were not as favorable as on apple on account of the oil mixing poorly with the water which was available at this place. A few live scale were found on the trees, while the more effective remedies showed no crawling young.

ONE FOR ALL.

This is a lime-sulfur compound to which is added a wool fat making a yellow soft grease. It is made by the Manhattan Oil Company, 51 Front Street, New York. One-For-All was sprayed on thirty-five peach trees in the Keller orchard March 23, 1910, at the rate of twenty-five pounds to fifty gallons of water.

It proved satisfactory in controlling the scale and possibly will serve as a useful insecticide, as the manufacturer has been able to add arsenate of lead to the above mixture, thus by a reduction in strength permitting its use on trees when in foliage and serving as both an insecticide and fungicide.

SAN-U-ZAY.

San-u-zay, a soluble oil, distributed by F. G. Street Company, Rochester, New York, was applied on thirty-two peach trees in the Keller orchard at the rate of one to fifteen. On account of difficulty in getting it mixed properly with water the results were unsatisfactory and will not warrant drawing conclusions as to its efficiency.

COOPER'S TREE SPRAY.

Cooper's tree spray V. was also applied on sixteen apple trees March 18, 1910, at the rate of one to fifty and one to one hundred. Also eight and ten peach trees were treated at the rate of one to one hundred and one to one hundred and fifty respectively in the Keller Orchard March 21, 1910. The results of this solution were so variable as to not justify an opinion of its ability to control the scale. This solution is manufactured by Williams, Cooper and Nephews, Chicago, Illinois.

NIAGARA BRAND LIME-SULFUR AND SPRA-ON.

It was planned that Niagara Brand Lime-Sulfur and Spra-on be tested also, but owing to transportation difficulties neither solution reached its destination until too late to be applied.

SYNOPSIS OF RESULTS.

The apple trees were badly infested with scale, while the peach were moderately so. Examination of the tests were made at different times during the summer. The results of the examinations are shown in the following table:

TABLE I.

Synopsis of Notes Taken During the Season.

Spray Mixture.	Strength.	Date of Application.	No. and Kind of Trees.	Effect in Killing Scale.
Lime-Sulfur Home Cooked.	20-15-50	Dec. 3, '09.	15 apple.	Good.
	20-15-50	Mar. 18, '10.	27 apple.	Good.
	20-15-50	Mar. 21, '10.	50 peach.	Very Good.
Concentrated Lime-Sulfur, Home Cooked.	60-125-50	Mar. 21, '10.	35 peach.	Very Good.
Orchard Brand Lime-Sulfur.	1-9	Nov. 27, '09.	32 apple.	Very Good.
	1-9	Mar. 18, '10.	18 apple.	Good.
	1-9	Mar. 23. '10.	35 peach.	Very Good.
Grasselli's Lime-Sulfur.	1-9	Dec. 3, '09.	12 apple.	Good.
	1-9	Mar. 17 '10.	34 apple.	Good.
Sherwin-Williams Lime-Sulfur.	1-9	Mar. 18, '10.	16 apple.	Good.
	1-9	Mar. 23, '10.	35 peach.	Very Good.
Bogart's Sulfur Compound.	1-9	Mar. 18, '10.	24 apple.	Good.
	1-9	Mar. 21, '10.	35 peach.	Very Good.
Lion Brand Lime-Sulfur.	1-9	Mar. 17, '10.	24 apple.	Good.
	1-9	Mar. 23, '10.	46 peach.	Very Good.
Neverscale.	50 lbs. to 50g	Mar. 18, '10.	30 apple.	Excellent.
	50 lbs. to 50g	Mar. 23, '10.	24 peach.	Excellent.
Vreeland's Lime-Sulfur.	1-9	Mar. 23, '10.	35 peach.	Very Good.
Scalime	1-9	Nov. 26, '09.	4 apple.	Good.
	1-9	Mar. 23. '10.	35 peach.	Very Good.
Scaleclean.	1-9	Mar. 21, '10.	35 peach.	Very Good.
Orchard Brand Soluble Oil.	1-15	Nov. 26, '09.	16 apple.	Very Good.
	1-15	Mar. 17, '10.	9 apple.	Excellent.
	1-15	Mar. 23, '10.	35 peach.	Very Good.
Scaloil.	1-15	Nov. 26, '09.	10 apple.	Fair.
	1-15	Mar. 17, '10.	33 peach.	Very Good,
Vacuum Oil.	1-15	Nov. 26, '09.	22 apple.	Fair Only.
	1-15	Mar. 17, '10.	18 apple.	Fair Only.
	1-15	Mar. 21. '10.	30 peach.	Poor.
Scalecide.	1-15	Mar. 21. '10.	34 peach.	Very Good.
One-For-All.	25 lbs. to 50g	Mar. 23, '10.	35 peach.	Very Good.
Rex Lime-Sulfur.	1-9	Mar. 21. '10.	35 peach.	Very Good.

SUMMARY OF RESULTS.

Apple Tests.

Considering the unfavorable weather conditions at time of application of remedies and the extremely bad infestation of the apple trees in the Stauffer orchard, the results from both fall and spring treatments were very good. Examination of all tests in June revealed scale breeding slightly on some trees, which would be expected. Both the lime-sulfur and oil sprays with exceptions noted above showed uniform good results. Practically no difference could be detected between the most effective lime-sulfur mixture and the best miscible oil.

The results and observation indicate that the lime-sulfur solutions when properly applied, are just as effective as the miscible oils for the control of scale on apple. They also show that the standard miscible oils can be employed on apple trees with safety. It is undoubtedly true that more thorough spraying should be done when treating apple with lime-sulfur than is required when using a miscible oil, due to the ability of the latter to spread. A comparison of fall and spring treatments in these tests seems to show a slight preference for fall treatment; that is, no difference was noted at examination in June, 1910, in the amount of scale killed, but fall sprayed tres seemed to have much greater vitality than those sprayed in spring. This would be expected in treating badly infested trees.

Peach Tests.

With the exception of three washes the results from all of the tests in the Keller orchard were very satisfactory, no difference being detected between the various lime-sulfur compounds and oil sprays. All of the manufactured concentrated lime-sulfur solutions tested between thirty and thirty-six degrees Beaume', while the home made concentrated tested twenty-seven degrees Beaume'. There was no injury to any of the peach trees by the oil sprays employed, yet experience with oil mixtures would not justify recommending their use in preference to the lime-sulfur in treating peach trees for the San Jose scale. They may be used without injury; then again they may cause severe injury in killing either buds or twigs.

THE LIME-SULFUR MIXTURES.

As mentioned in the introduction one or the other forms of lime-sulfur mixture is accepted as an established remedy for the San Jose Scale. The question among the majority of orchardists now, is whether to continue to use the old home made wash, or one of the manufactured concentrated solutions, or to make the concentrated preparation themselves. The answer to the question will largely be governed by conditions.

The fungicidal value of this character of wash cannot be doubted. For in addition to being a preventative of leaf curl it undoubtedly aids in the control of other fungus troubles. So far as we have observed, there is practically no difference between the concentrated solution and the home made wash in their ability to lessen the injury from leaf curl.

The employment of the self-boiled lime-sulfur as a preventative of brown rot on peach and the recent use of a greatly diluted solution of the concentrated mixture for other diseases, attacking fruit and foliage, enhance the general utility of this class of spray mixtures.

The various concentrated lime-sulfur solutions have been tested at other experiment stations and also tried out by orchardists, in some cases on an extended scale, and so far as observed have compared favorably with the regular home made lime-sulfur wash in efficiency. Their use became quite extensive in this State during the past year, indicating that orchardists prefer buying the wash rather than make the solution. With this class of growers, the question of what brand to use is paramount. From these tests, it would seem that practically all the well known concentrated solutions can be expected to give good results if their standard is maintained. Every grower should procure a hydrometer and determine the density of the prepared wash and from that the dilution to be used.

It has been determined that the strength of a standard made mixture, that is, the degree of concentration, which is usually seven or more times as strong as the home made mixture, can largely be determined by its density or specific gravity provided there are no adulterations. Thus the hydrometer may be used to ascertain this density and dilution may then be made in accordance with the table given on page ....

Therefore, it is recommended that only well known or previously tested manufactured solutions be used.

Any concentrated lime-sulfur preparation should test between 26½ and 32 degrees Beaume', and thus be diluted one to seven or nine respectively. The manufactured product should be a clear amber, reddish, or deep cherry colored liquid with very little sediment.

The Home made Concentrated Lime-Sulfur.

The apparent efficiency, convenience in handling and readiness to start spraying at once when weather conditions are favorable have caused the rather extensive use of the different brands of concentrated solution in this State. The demand for this solution has caused several new brands to appear on the market, several of which are prepared by private parties, that is, persons who had special outfits for making the regular home made solution prepared the concentrated solution and offered it for sale in their respective vicinities.

It is thus possible for large orchardists who have previously made the home made solution at time of spraying to now make the concentrated at a time when spraying is impracticable, store it and have the solution ready for use when needed. The labor problem at spraying time is thus aided and advantage can be taken of half days or other times when conditions are favorable.

Undoubtedly making the home concentrated is only practicable for those orchardists who require a large amount of solution. In such cases it is more economical, if the boiling outfit is intact, to make the concentrated than to buy from manufacturers.

The standard brands of concentrated are sold retail at about 200 a gallon in barrel lots. The lime usually costs about 50c. per bushel and the sulfur 2¾c. per pound. The grower can estimate what boiling and storing the solution will cost and compare the total with the present market price of commercial brands.

For those who may desire to make their own concentrated mixture a formula is given below, which has been tested by this department in actual field operations and found to be effective. This is the method as outlined by P. J. Parrot, of the New York Geneva Experiment Station, in Bulletin 320.

Formula:

Lump lime	60 lbs.
Sulfur (flour or flowers)	125 lbs.
Water	50 gal.

Directions:—Slake lime to a consistency of thin paste, and add the sulfur. Stir the materials thoroughly to break up lumps. Boil vigorously for one hour. At start, enough water should be allowed to provide for evaporation in boiling. This will require from 10-15 gallons. The finished product may either be strained into barrels or other containers or it may be used at once after proper dilution. Home made concentrated should test 26 degrees to 32 degrees Beaumé and should be diluted according to the table given on page ...

In storing the solution, it is necessary to exclude air from it as much as possible by either filling up the barrel or other container completely with the solution, or by putting a film of oil on the surface of the liquid. The stored solution should be protected from extreme cold weather. According to Stewart, of the Pennsylvania Station, a solution of 1.28 density (32.1° Beaume') will not freeze at 5° F., and will usually recover completely should it be frozen at a lower temperature. If some crystals should form they may be strained out and redissolved by boiling and returned to the wash.

When ready for spraying the concentrated solution should be tested with the hydrometer, if this is not done after making, in order to determine the dilution that is desired. The table on page .. gives the dilutions for the respective densities on a basis of the regular home made solution.

The cooker used in making the regular lime-sulfur wash will serve to make the concentrated solution. This may be a home made vat, as was shown in bulletin 112 of this station, or a convenient iron boiler can be purchased for the work. Such boilers are often of use for other purposes on the farm.

The concentrated solution can be more easily made, of course, by boiling the mixture with steam coils in either wood or metal vessels, and, undoubtedly, those who have such outfits are more likely to undertake making this solution.

THE HYDROMETER.

As previously mentioned, in order to dilute the concentrated solutions in accordance with their degree of concentration they should be tested with a hydrometer. While this test will not reveal impurities, it will serve to indicate the proper dilution in a regularly prepared mixture.

The Hydrometer is a glass instrument, something like a thermometer in shape. In testing a liquid the hydrometer is placed in it bulb down, and the reading is made at the surface of the liquid in which it is supported. The instruments are made in two scales, the specific gravity and the Beaume'. Both may be placed on the same instrument. Readings on the Beaume' scale are given in degrees, while the reading on the specific gravity is given in decimals.

The Beaume' scale is easier to read and, while more difficult to estimate from, in this case will serve with the aid of the tables given below.

Hydrometers can be secured for about $1.25 from Authur H. Thomas, of Philadelphia, Pennsylvania; Eimer & Amend, of New York City, and other dealers in such apparatus. In securing an instrument the range on Beaume' scale should be 0° to 36° and 1.000 to 1.35 on the specific gravity scale.

TABLE FOR DILUTING CONCENTRATED SOLUTIONS.

Density Beaume' Scale.	Density Specific Gravity Scale.	For San Jose Scale Dilute With Water At These Rates.
35	1.3181	1 to 9
34	1.3063	1 to 8½
33	1.2946	1 to 8
32	1.2831	1 to 7¾
31	1.2719	1 to 7½
30	1.2608	1 to 7
29	1.2500	1 to 6¾
28	1.2393	1 to 6½
27	1.2288	1 to 6
26	1.2184	1 to 5¾

Regular Home Made Lime-Sulfur.

For a number of years this has been the standard lime-sulfur solution used to control the scale.

Considerable latitude is allowable in the quantity of materials used, and in the manner of making this mixture, within which uniformly good results may be obtained. The materials may be boiled in a home made vat or hog scalder. A small boiler or a regular steam engine may be employed where it is desired to make the wash on a large scale.

There is practically no difference in the use of flour or flowers of sulfur in making the wash, and as the flour of sulfur is cheaper it would seem more practical to employ this grade.

Formula:

Stone lime, ...	20 lbs.
Flowers or flour of sulfur	15 lbs.
Water to make	50 gal.

Directions:—Put twenty gallons of water in an iron vat, or hog scalder and bring to a boil; then add the stone lime and sulfur. The sulfur should be made into a paste, with hot or cold water before placing it in the boiler, in order to facilitate its mixing. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulfur is completely dissolved, and a clear amber-colored solution produced. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer, with at least twenty meshes to the inch, into the spray barrel and apply to the tree while warm.

Time of Application.

No particular difference has been observed in the effectiveness of the lime-sulfur wash, whether applied in the fall or early spring, during the dormant season. It is believed, however, that early spring is the best time to spray, as the mixture will remain on the trees for a longer period during the summer, when the scale is breeding, and this is desirable. In some cases, where there is a great amount of spraying to be done, it is well to do a part of it in the late fall, as spring weather conditions often allow but a short period for spraying; also other spring work may interfere. It is safe to say that 90 per cent. of the spraying in Maryland is done in the spring, and there is little doubt that that period is preferable. It must be borne in mind that the lime-sulfur wash is a treatment for dormant trees, and it should not be applied after the buds open.

Mode of Application.

No matter how good the materials used, if the spraying is not done thoroughly, the results will be disappointing. Too much stress cannot be laid upon this phase of the work. One of the advantages of the lime-sulfur wash is, that after the spray has dried on a tree, the twigs or limbs that have been missed are easily seen, and such trees should be gone over a second time. Especially should the terminal parts be thoroughly covered, as the young insects always seek the new, tender wood.

If a few infested trees have been found in an orchard, spray the whole orchard. The pest is always more widely distributed than an inspection would ordinarily indicate.

In the selection of a pump for spraying purposes, the particular size, etc., is left to the judgment of the orchardist. The majority of the pumps on the market will give satisfaction, and the conditions under which spraying is done are so varied that only general recommendations can be made. There is no doubt that the ordinary barrel pump is more generally used than any other kind, but the power sprayer and double-acting pumps have their place, where there is a large amount of work to be accomplished.

Spraying, at best, with an insecticide or fungicide is rather disagreeable work, and the sprayman should be fitted out with rubber or oilskin coat, hat and gloves. It is also a good plan to rub vaseline on the hands and face to prevent the spray from irritating the flesh. Make it a point to have a sufficient length of hose, twenty feet to each lead, should be the minimum length for orchard work. This will enable the spraymen to go all around the ordinary tree without moving the sprayer. Extension rods are necessary, as well as a tower on the wagon when spraying large trees. What has been stated in regard to pumps, may also be said of the different nozzles on the market. Some prefer the fan-shaped, others a conical spray. However, it is believed that the Friend type of nozzle is best. In conclusion select the apparatus best suited to your needs, and conduct the work in a thorough manner.

The following are manufacturers and dealers in pumps and supplies:

Griffith & Turner Co., Baltimore, Maryland.
Goulds Manufacturing Company, Seneca Falls, N. Y.
The Deming Company, Salem, Ohio.
Morrill & Morley, Benton Harbor, Michigan.
Field Force Pump Company, Elmira, N. Y.
Myers Pump Co., Ashland, Ohio.
George H. Stahl, Quincy, Illinois.
Spray Motor Company, Buffalo, N. Y.
F. W. Bolgiano & Co., No. 935 M St., N. W., Washington, D. C.

FUMIGATION EXPERIMENTS.

Fumigation of nursery trees is as yet accepted as the most satisfactory treatment for stock which is likely to be infested with San Jose Scale. It cannot be considered as sure death to all scale insects present for obvious reasons, but it is the best preventative against the distribution of the scale by nursery stock. It is also a good practice for nurserymen to fumigate all buds or other propagating stock that is employed. This practice, however, is not so generally adhered to as is the fumigation of salable trees, for the latter is required by law in this State. One reason why some nurserymen neglect to fumigate their stock is the fear of injuring it with the gas.

Experiments in the fumigation of peach buds were conducted during the season of 1908 and recorded in bulletin 131 of this station. It was with a desire to repeat these tests, as well to serve as a demonstration, that the following tests were conducted during the past year.

The test was conducted in a large block of peach nursery stock, one row being selected in the midst of the block so that conditions would be as normal as possible. The Champion variety was used and buds were set or budded by a regular workman. Also all buds were tied by the same person. Owing to inaccurate counts, in some cases, more or less than 100 buds were used with each strength of the gas. Five strengths of the hydrocyanic acid gas, were used, and each strength was employed for two time periods. The gas was made in the regular manner according to the 1-2-4 formula and the buds were fumigated in an air tight box. Checks of approximately 100 buds untreated were budded between each plot of fumigated buds. The work was conducted on August 30, 1909, a clear warm day.

On November 19, 1909, notes were taken on the condition of all the buds in the experiment, the buds being examined by an expert. The following table gives the strength of gas used and time of fumigation, and results on each lot of buds:

TABLE II.—Results of Bud Fumigation Experiments.

No.	Grams of K. Cn.	Equivalent to oz. per 100 cu. ft.	Total Buds.	Time Period.	Live Buds.	Dead Buds.
1	1.25	1	90	30 Min.	84	6
2	Check.		100		97	3
3	1.25	1	104	60 Min.	98	6
4	Check.		102		97	5
5	1.85	1½	92	30 Min.	86	6
6	Check.		110		108	2
7	1.85	1½	118	60 Min.	113	5
8	Check.		102		97	5
9	2.95	2½	100	30 Min.	100	0
10	Check.		109		106	3
11	2.95	2½	103	60 Min.	102	1
12	Check.		104		101	3
13	3.75	3	93	30 Min.	93	0
14	Check.		97		97	0
15	3.75	3	97	60 Min.	93	4
16	Check.		96		96	0
17	4.90	4	94	30 Min.	93	1
18	Check.		101		100	1
19	4.90	4	101	60 Min.	100	1
20	Check.		126		125	1

Results similar to the above were noted in the spring, May 23, 1910. It is thus seen that even the extreme of four times the regular strength, of one ounce of cyanide to one hundred cubic feet, and twice the period of time had no apparent effect upon these tender buds. In the light of the extended work in testing the effect of HCn. on nursery trees and buds shown by this and other stations, it should be expected that no nurseryman would hesitate to properly fumigate in accordance with the 1-2-4 formula all propagating stock likely to be infested with the San Jose Scale. Also that orchardists should have no fear of injury to dormant nursery stock from fumigation by the responsible nurseryman; who will see that the fumigation is properly conducted. The latitude that these and other tests show, reduces the possibilities of such injury to the minimum.

DIPPING EXPERIMENTS.

The results of dipping nursery trees in various solutions, in order to determine their value as substitutes for fumigation or as an additional treatment, were inconclusive in the tests conducted in 1908. Similar work by other stations did not clear the subject. As inquiries concerning this treatment were constantly being received, another series of tests was begun on November 26 and 27, 1909, and continued on March 28 and 29, 1910.

In taking notes and summing up the results of these experiments two phases were considered: The effectiveness of the solutions in killing scale, and their effect on the growth of the tree.

One hundred and eighty apple trees and the same number of peach trees were used in the fall and a like number in the spring. Only the apple trees were infested with San Jose Scale.

Seven insecticides were used: Home made lime-sulfur at two temperatures, approximately 60° and 120° F. Orchard Brand Lime-Sulfur, kerosene, twenty per cent. kerosene emulsion, Soluble Oil, one to fifteen, Scalecide, one to fifteen, and whale oil soap, two pounds to one gallon of water. For checks ten apple and ten peach trees treated with hydrocyanic acid gas (1-2-4 formula) for one hour in the fall tests and one-half hour in the spring tests, and ten untreated apple and ten untreated peach trees were used both in the fall and spring. Owing to the cold weather in the fall, it was impossible to keep the temperatures of the solutions constant, and instead of 120° F., the temperature was 113° F., and instead of 60° F., the dipping was begun at 95° F., with the record at the final immersion of the lot 60° F. In the spring the temperatures were 118° F., and 69° F., these remaining fairly constant.

Two time periods were observed: The first, given as "immersion" in the tables, consisted of dipping and removing the trees as rapidly as possible, in the second case, the trees remained submerged for three minutes.

All the trees were protected from rapid drying and were planted either on the same day they were dipped or the following day; those left for the second day's planting were healed in over night.

The details of the tests are shown in Tables III to VI.

TABLE III.

Trees Dipped, Tops Only—Fall 1909.

Remedy.	Time Period	No. Trees	Vegetative state, May 4, 1910.	Vegetative State. May 16, 17, '10.	Scale, June 27, 28.
Home made lime sulphur at 120° F.	Immersion.	5 apple.	2 showed leaves 1 growing buds 1 showed nothing. 1 broken.	All growing.	No scale.
		5 peach.	3 showed leaves 1 showed nothing. 1 growing buds	All growing.	
	Three Min.	5 apple.	3 showed leaves 2 showed buds. Tops killed.	Just as on May 4.	No scale.
		5 peach.	4 showed leaves 1 showed nothing. Tops killed.	All growing.	
Home made lime sulphur at 60° F.	Immersion.	5 apple.	1 growing buds 1 dormant buds 3 nothing.	3 showed buds.	1, live scale 4, no scale
		5 peach.	1 showed leaves 2 dormant buds 2 growing buds	All growing.	
	Three Min.	5 apple.	1 showed leaves 2 growing buds. 1 dormant buds 1 nothing.	All growing.	, dead scale. 4, no scale
		5 peach.	4 showed leaves 1 showed buds.	All growing.	
Orchard Brand Lime Sulphur 1-9	Immersion.	5 apple.	4 showed leaves 1 showed buds.	All growing.	No Scale.
		5 peach.	5 showed leaves	All growing.	
	Three Min.	5 apple.	5 showed leaves Tip of twigs killed.	All growing.	No scale.
		5 peach.	3 showed leaves 1 showed buds. 1 showed nothing	All growing.	
Kerosene.	Immersion.	5 apple.	5 showed leaves at base	All growing from base.	No scale. 1 tree dead
		5 peach.	3 showed leaves at base. 2 showed nothing.	All growing from base.	
	Three Min.	5 apple.	4 showed leaves at base. 1 dormant buds	All growing from base.	No scale. 1 tree dead

TABLE III.—Continued.

Trees Dipped, Tops Only—Fall 1909.

Remedy.	Time period	No. Trees.	Vegetative State, May 4, 1910.	Vegetative State, May 16, 17, '10.	Scale, June 27, 28.
Kerosene	Three Min.	5 peach.	2 showed leaves at base. 3 showed nothing.	All growing from base.	
Kerosene emulsion.	Immersion.	5 apple.	3 showed leaves 2 showed buds.	All growing. from base.	No scale. 1 tree dead All bark injured.
		5 peach.	2 showed leaves 3 showed nothing.	All growing. 3 in bud.	
	Three Min.	5 apple.	4 showed leaves 1 dormant buds	5 in leaf.	No scale. 1 tree dead All bark injured.
		5 peach	5 showed no signs of growth	4 in leaf. 1 in bud.	
Orchard brand soluble oil.	Immersion.	5 apple.	3 showed leaves 1 dormant buds 1 buds.	All growing.	No scale.
		5 peach.	1 showed leaves 1 dormant buds 3 showed nothing.	All growing in leaf or bud.	
	Three Min.	5 apple.	2 showed leaves 2 growing buds 1 showed nothing.	All but one growing from base.	No scale.
		5 peach.	5 showed no growth.	All in leaf or bud.	
Scalecide.	Immersion.	5 apple.	5 showed leaves	All growing.	3, dead scale. 2, no scale Bark injured.
		5 peach.	1 showed leaves 4 growing buds	All growing.	
	Three Min.	5 apple.	4 showed leaves 1 growing buds	All showing growing buds.	3, dead scale. 2. no scale Bark injury.
		5 peach.	2 growing buds 2 dormant buds 1 nothing.	All growing.	
Whale oil soap.	Immersion.	5 apple.	5 showed leaves	All growing.	1, live scale 4, no scale

TABLE III.—Continued.

Trees Dipped, Tops Only—Fall 1909.

Remedy.	Time Period	No. Trees.	Vegetative State, May 4, 1910.	Vegetative State May 16, 17, '10.	Scale, June 27, 28.
Whale oil soap.	Immersion.	5 peach.	2 showed leaves 1 dormant buds 1 showed nothing.	All growing.	
	Three Min.	5 apple.	5 showed leaves	4 growing.	1, live scale 4, no scale
		5 peach.	2 showed leaves 3 growing buds	1 growing.	
Hydrocyanic acid gas, 1-2-4. Half hour.		10 apple.	All growing.	7 growing.	1, live scale 1, dead scale. 8, no scale
		10 peach.	All growing.	10 growing.	
Checks untreated.		10 apple.	All growing.	5 growing vigorously. All grew later.	4, live scale 2, dead scale. 4, no scale
		10 peach.	2 in leaf. 8 dormant buds	All growing.	

TABLE IV.

Trees Dipped, Tops and Roots—Fall 1909.

Remedy.	Time Period	No. Trees	Vegetative State of trees, May, 4, 1910.	Vegetative State of trees, May 16, 17, '10	Scale, June 27, 28, 1910.
Home made lime sulfur 120° F.	Immersion.	5 apple.	3 in leaf. 2 growing buds	All in leaf.	3, no scale 1, scale dead.
		5 peach.	2 in leaf. 2 growing buds 1 nothing.	1 growing buds 4 showed nothing.	
	Three Min.	5 apple.	2 in leaf. 2 dormant buds 1 nothing.	2 in leaf. 3 dormant buds	3, no scale. 1, dead scale. 1, dead tree.
		5 peach	2 in leaf, 1 growing and 2 dormant buds.	5 showed nothing.	
Home made lime sulfur 60° F.	Immersion.	5 apple.	2 growing and 1 dormant buds 2 nothing.	4 showed leaves 1 showed buds.	1, live scale 4, no scale
		5 peach.	1 in leaf. 4 in buds	5 showed nothing.	
	Three Min.	5 apple.	5 in leaf.	5 in leaf.	1, dead scale. 4, no scale
		5 peach.	2 in leaf. 2 in buds. 1 dormant bud.	2 in leaf. 3 showed nothing.	
Orchard Brand Lime Sulfur	Immersion.	5 apple.	4 in leaf. 1 growing buds at base.	5 in leaf.	5, no scale
		5 peach.	4 in leaf. 1 growing buds	4 in leaf. 1 bud.	
	Three Min.	5 apple.	5 in leaf.	5 in leaf.	3, no scale 2, dead scale.
		5 peach.	5 in leaf.	5 in leaf.	
Kerosene.	Immersion.	5 apple.	4 in leaf at base. 1 buds.	4 in leaf. 1 dead.	All trees dead.
		5 peach.	5 showed no signs of life.	5 showed no signs of life.	
	Three Min.	5 apple.	1 in leaf. 2 leaves at base. 2 nothing.	3 showed leaves 2 nothing.	4 trees dead. 1 bark injured. No Scale.
		5 peach.	5 showed no signs of life.	5 showed no signs of life.	

TABLE IV.—Continued.

Trees Dipped, Tops and Roots—Fall 1909.

Remedy.	Time Period	No Trees.	Vegetative State of trees, May 4, 1910.	Vegetative State of trees, May, 16, 27, '10	Scale, June 27, 28, '10.
Kerosene emulsion.	Immersion.	5 apple.	1 in leaf. 1 leaves at base 3 dormant buds	2 in leaf. 3 dormant buds	4 trees dead. 1 bark injured. No scale.
		5 peach.	5 showed no sign of life.	5 showed no sign of life.	
	Three Min.	5 apple.	5 dormant buds	1 in leaf. 4 dormant buds	4 trees dead. 1 bark injured. No scale.
		5 peach.	5 showed no signs of life	5 showed no sign of life.	
Orchard Brand Soluble Oil. 1-15.	Immersion.	5 apple.	4 showed leaves. 1 dormant buds	4 in leaf. 1 showed nothing.	4, no scale 1 tree dead
		5 peach.	2 showed leaves 3 growing buds	4 in leaf. 1 in bud.	
	Three Min.	5 apple.	4 showed buds. 1 showed leaves	5 in leaf.	5, no scale
		5 peach.	3 showed leaves 2 showed nothing.	3 in leaf. 2 showed nothing.	
Scalecide. 1-15.	Immersion.	5 apple.	4 showed growing buds. 1 showed dormant buds.	1 in leaf. 3 in bud. 1 nothing.	5, no scale All have bark injured.
		5 peach.	1 showed leaves 1 growing and 3 dormant buds	n leaf. 1 nothing. 2 in bud.	
	Three Min.	5 apple.	5 in leaf.	5 in leaf.	3, no scale 2, dead scale.
		5 peach.	2 showed buds. 3 showed nothing.	1 in leaf. 2 nothing. 2 in bud.	
Whale oil soap.	Immersion.	5 apple.	5 showed leaf.	5 in leaf.	5, no scale
		5 peach.	5 showed leaves	5 in leaf.	
	Three Min.	5 apple.	5 showed leaves	5 in leaf.	4, no scale 1, live scale
		5 peach.	4 showed leaves 1 dormant buds	4 in leaf. 1 in bud.	

TABLE IV.—Continued.

Trees Dipped, Tops and Roots—Fall 1909.

Remedy.	Time Period	No trees.	Vegetative. State of trees, May 4, 1910.	Vegetative. State of trees, May 16, 17, '10	Scale, June 27, 28, '10.
Hydrocyanic acid gas, 1-2-4. 1 hour.	1 hour.	10 apple.	All growing.	7 growing.	1, live scale 1, dead scale. 8, no scale
		10 peach.	All growing.	10 growing.	
Checks Untreated.		10 apple.	All growing.	5 growing vigorously. All grew later.	4, live scale 2, dead scale. 4, no scale
		10 peach.	2 in leaf. 8 dormant buds	All growing.	

RESULTS OF THE FALL TESTS.

Lime -sulfur at 120° F.

Trees dipped, tops only, in this solution came out and continued to grow well. No differences were apparent between the two time periods. All scale killed.

Trees dipped, tops and roots, showed damage when allowed to remain three minutes. Otherwise no injury. No live scale found.

Lime-sulfur at 60° F.

Trees dipped, tops only, in this solution grew well. Live scale was found on one tree.

Trees dipped, tops and roots, showed no advantage of the immersion over the three minute period with the apple trees, but a slight advantage with the peach trees. This was offset by the discovery of one live scale on the apple trees immersed only.

Orchard Brand Lime-Sulfur.

All trees started well and continued to grow vigorously, and no live scales were found.

Kerosene.

Those dipped, tops only, started out from the base but many died later. Those completely dipped died. All scale killed.

Kerosene emulsion.

Those trees dipped, tops only, grew very well but eighteen of the twenty totally submerged were killed. No live scale.

Orchard Brand Soluble Oil.

Of these trees dipped, tops only, five were killed to the base but grew out, while three of the trees totally submerged died. No scale present.

Scalecide.

Effect on scale was excellent and growth good in most cases, except that the bark of almost all was badly blistered.

Whale Oil Soap.

The growth of the majority of the trees was satisfactory, the foliage being more vigorous than on any trees treated or untreated, but three trees with live scale were found.

Hydrocyanic acid gas.

All trees grew well, but one live scale was found among the ten trees.

Checks untreated.

All grew well but showed four with live scale.

TABLE V.

Trees Dipped, Tops Only—Spring 1910.

Remedy	Time Period	No. Trees.	Vegetative State, May 4, 1910.	Vegetative State, May 16, 17, '10.	Scale, June 16, 17, 1910.
Home made lime sulphur 120° F	Immersion.	5 apple.	4 with leaves. 1 with buds.	5 in leaf.	4, no scale. 3, dead scale.
		5 peach.	5 in bud.	5 in leaf.	
	Three Min.	5 apple.	2 in bud. 3 in leaf.	2 in bud. 3 in leaf.	2, no scale. 3, dead scale.
		5 peach.	4 in bud. 1 nothing.	5 in leaf.	
Home made lime sulphur 60° F.	Immersion.	5 apple.	4 in leaf. 1 in bud.	5 in leaf.	2, no scale 3, dead scale.
		5 peach.	No peach far enough advanced to take notes.	3 in bud. 2 nothing.	
	Three Min.	5 apple.	4 in leaf. 1 in bud.	5 in leaf.	5, with no scale.
		5 peach.		5 in leaf.	
Orchard Brand Lime Sulphur 1-9	Immersion.	5 apple.	5 in leaf.	5 in leaf.	3, with no scale. 2, with dead scale
		5 peach.		4 in leaf. 1 in bud.	
	Three Min.	5 apple.	4 in leaf. 1 in bud.	5 in leaf.	2, with no scale. 3, with dead scale
		5 peach.		3 in leaf. 2 in bud.	
Kerosene.	Immersion.	5 apple.	3 in bud. 2 buds at base.	5 in leaf.	5, no scale 2, top injured. 1, bark injured.
		5 peach.		4 in leaves at base. 1 in bud.	
	Three Min.	5 apple.	1 in bud. 4 nothing.	5 in leaves at base.	4, no scale 1, with dead scale 3, tops killed.

TABLE V.—Continued.

Trees Dipped, Tops Only, Spring 1910.

Remedy.	Time Period	No. Trees.	Vegetative State, May 4, 1910.	Vegetative State, May 16, 17, '10.	Scale, June 28, 29, 1910.
Kerosene.		5 peach.		4 in leaf at base 1 in buds at base.	
Kerosene emulsion.	Immersion.	5 apple.	5 with dormant buds.	2 in leaf. 3 in buds.	2 with no scale. 3 with dead scale
		5 peach.		5 with leaves at base.	
	Three Min.	5 apple.	4 in bud. 1 nothing.	5 with leaves.	4 with no scale. 1 with dead scale.
		5 peach.		5 with leaves.	
Orchard Brand Soluble Oil. 1-15.	Immersion.	5 apple.	5 in bud.	4 in leaf. 1 in bud.	5 with no scale.
		5 peach.		4 in leaf. 1 in bud.	
	Three Min.	5 apple.	3 in growing buds. 2 in dormant buds.	3 in leaf. 2 in bud.	5 with no scale.
		5 peach.		1 leaves at base. 3 buds at base. 1 nothing.	
Scalecide.	Immersion.	5 apple.	4 in leaf. 1 in bud.	5 in leaf.	4 with no scale. 5 with dead scale.
		5 peach.		5 in leaf.	
	Three Min.	5 apple.	2 in leaf. 3 in bud.	5 in leaf.	4 with no scale. 1 with dead scale.
		5 peach.		1 in leaf. 4 in bud.	
Whale Oil Soap.	Immersion.	5 apple.	1 in leaf. 4 in bud.	5 in leaf.	5 with no scale.
		5 peach.		1 in leaf. 1 in bud. 3 nothing.	
	Three Min.	5 apple.	4 in bud. 1 nothing.	4 in leaf. 1 nothing.	4 with no scale. 1 tree dead.
		5 peach.		3 in leaf. 1 in bud. 1 nothing.	

TABLE V—Continued.

Trees Dipped, Tops Only, Spring, 1910.

Remedy.	Time Period	No. Trees.	Vegetative State, May 4, 1910.	Vegetative State, May 16, 17, 1910.	Scale, June 28, 29, 1910.
Hydrocyanic acid gas. 1-2-4.	1 hour.	10 apple.	9 in leaf. 1 in bud.	All growing.	1 tree with live scale. 9 trees with no scale.
		10 peach.		All growing.	
Checks Untreated.		10 apple.	8 in leaf. 2 in bud.	10 in leaf.	4 with live scale. 4 with no scale. 2 with dead scale.
		10 peach.		All growing.	

TABLE VI.

Trees Dipped, Tops and Roots, Spring, 1910.

Remedy.	Time Period	No. Trees.	Vegetative State of Trees May 4, 1910.	Vegetative State of Trees May 16, 17, '10.	Scale, June 28, 29, 1910.
Home made lime-sulfur 120° F.	Immersion.	5 apple.	4 with leaves. 1 with buds.	5 showed leaves.	4, no scale 1, dead scale.
		5 peach.	No peach far enough advanced to take notes.	1 showed buds. 4 nothing.	
	Three Min.	5 apple.	2 growing buds 3 dormant buds	2 showed leaves. 3 dormant buds	1, no scale 4, dead scale.
		5 peach.		No signs of buds pushing out.	
Home made lime-sulfur 60° F.	Immersion.	5 apple.	1 in leaf. 4 in bud.	4 in leaf. 1 in bud.	1, live scale. 3, no scale 1, dead scale.
		5 peach.		No signs of buds pushing out.	
	Three Min.	5 apple.	3 in leaf. 2 in bud.	5 in leaf.	5, no scale
		5 peach.		3 in leaf. 2 showed nothing.	
Orchard Brand Lime-Sulfur 1-9.	Immersion.	5 apple.	5 in leaf.	5 in leaf.	4, no scale 1, dead scale.
		5 peach.		3 in leaf. 2 in bud.	
	Three Min.	5 apple.	4 in leaf. 1 in bud.	5 in leaf.	5, no scale
		5 peach.		No signs of bud pushing out.	
Kerosene.	Immersion.	5 apple.	2 dormant buds.	Nothing showing.	Trees all dead.
		5 peach.	3 nothing.	Nothing showing.	
	Three Min.	5 apple.	1 showed buds. 4 nothing.	1 in leaf. 1 in bud. 3 nothing.	4 trees dead. No scale on others
		5 peach.		2 in bud. 3 nothing.	

TABLE VI—Continued.

Trees Dipped, Tops and Roots, Spring, 1910.

Remedy.	Time Period	No. Trees.	Vegetative State of Trees, May 4, 1910.	Vegetative State of Trees, May 16, 17, '10.	Scale, June 28, 29, 1910.
Kerosene emulsion.	Immersion.	5 apple.	5 showed buds.	3 in leaf. 2 in bud.	3 trees dead. 2, no scale
		5 peach.		1 with leaves at base. 2 with buds at base. 2 with nothing.	
	Three Min.	5 apple.	4 showed buds. 1 nothing.	1 with leaves. 3 with buds. 1 nothing.	3 trees dead. 2, no scale
		5 peach.		4 with leaves. 1 with nothing.	
Orchard Brand Soluble Oil.	Immersion.	5 apple.	5 showed growing buds.	3 in leaf. 1 in bud. 1 nothing.	4, dead scale. 1, no scale
		5 peach.		4 in leaf. 1 in bud.	
	Three Min.	5 apple.	2 showed dormant buds. 3 growing buds.	1 in leaf. 2 in bud. 2 nothing.	5, no scale
		5 peach.		3 in leaf. 2 in bud.	
Scalecide.	Immersion.	5 apple.	1 showed leaves. 4 showed buds.	2 in bud. 3 nothing.	4, no scale 1, dead scale.
		5 peach.		5 in leaf.	
	Three Min.	5 apple.	5 showed growing buds.	2 in leaf. 2 in bud. 1 nothing.	5, no scale
		5 peach.		4 in leaf. 1 in bud.	
Whale Oil Soap.	Immersion.	5 apple.	4 showed growing buds. 1 showed dormant buds.	2 in leaf. 1 in bud. 2 nothing.	2, live scale. 2, no scale 1, dead scale.
		5 peach.		4 in leaf. 1 in bud.	
	Three Min.	5 apple.	1 showed leaves 3 growing buds. 1 nothing.	2 in leaf. 2 in bud. 1 nothing.	3, no scale 1, dead scale. 1 dead tree.
		5 peach.		4 in leaf. 1 nothing.	

TABLE VI—Continued.

Trees Dipped, Tops and Roots, Spring, 1910.

Remedy.	Time Period	No. Trees.	Vegetative State of Trees, May 4, 1910.	Vegetative State of Trees, May 16, 17, '10.	Scale, June 28, 29, 1910.
Hydrocyanic acid gas.	1 Hour.	10 apple.	9 showed leaves. 1 buds.	All growing.	1, live scale. 9, no scale
		10 peach.		All growing.	
Checks Untreated.		10 apple.	8 showed leaves. 2 buds.	All growing.	4, live scale. 4. no scale 2, dead scale.
		10 peach.		All growing.	

RESULTS OF THE SPRING TESTS.

Home made lime-sulfur 118° F.

Growth of trees somewhat retarded, but all grew well after June 1. No live scale.

Home made lime-sulfur 69° F.

Growth somewhat retarded but all grew well after June 1. One tree with live scale, among those dipped tops and roots.

Orchard Brand Lime-Sulfur.

Peach trees whose tops and roots were dipped for three minutes showed some retardation, but otherwise all did well. No live scale could be discovered.

Kerosene.

The injurious effects of the dip were severe in all cases.

Kerosene emulsion.

The injurious effects from this solution were marked.

Orchard Brand Soluble Oil.

The growth in this case was slow but all finally grew well. All scale dead.

Scalecide.

Growth was satisfactory and no live scale could be discovered.

Whale oil soap.

Two trees were killed, one tops only dipped, and one tops and roots dipped. Two trees with live scale were found among those entirely submerged.

Hydrocyanic acid gas.

Growth good, but one tree with live scale was found.

Checks untreated.

Growth good. Four trees with live scale.

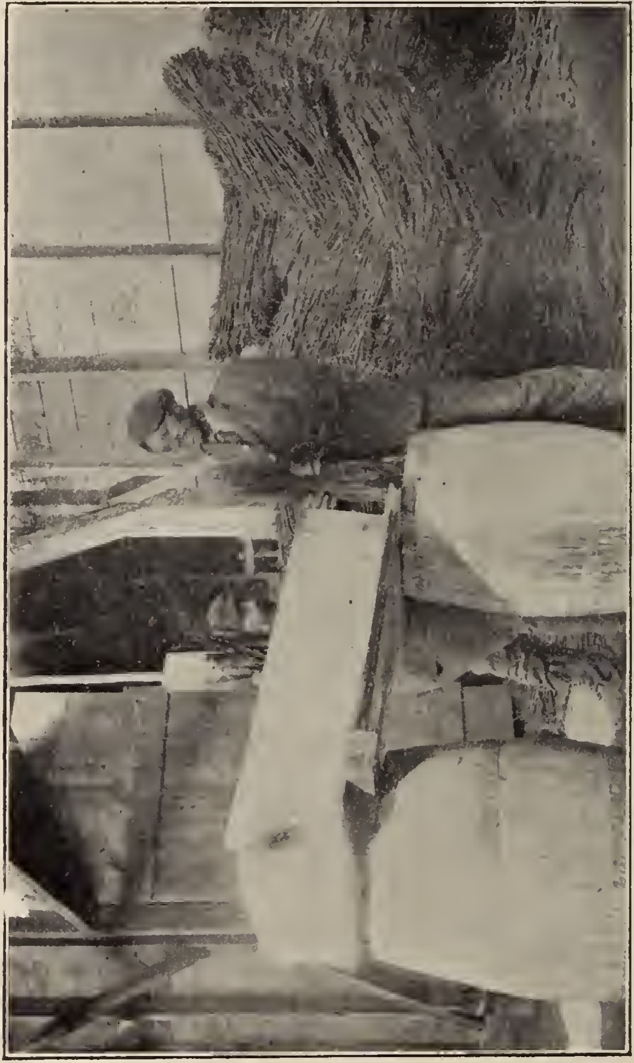

Fig. 3.—Dipping apple seedlings in concentrated lime-sulfur at a dilution of 1-9. (Cory.)

SUMMARY OF RESULTS.

1. Instantaneous immersion at normal temperature, is the only practical method that can be employed.
2. Spring dipping seems to be inadvisable, because the growth is retarded to a marked extent.
3. Fall dipping with lime-sulfur mixtures gives promise of becoming very useful, as a supplementary treatment for nursery stock.
4. All oils killed or injured the tops of so many of the trees, that they proved useless as dips.
5. Hydrocyanic acid gas produced no undesirable effects on the growth of the trees. While it cannot be considered as a perfect remedy for ridding trees of scale yet it is the best preventative that may be employed. At the same time its power to kill all scale is not constant.
6. It appears that whale oil soap as a fall dip is promising, but more extensive tests with various types and strengths must be made before definite conclusion can be reached.
7. In February and March, 1910, the writer witnessed some dipping operations that are of interest in connection with these experiments. At one of the nurseries in this State over one million apple seedlings were dipped, tops and roots, in a commercial brand of lime-sulfur at the rate of one part to nine of water, and nearly the same number of pear seedlings were dipped, tops only. In August these blocks were visited and an excellent stand had been secured.
8. As an additional result, not anticipated, it was found that no Wooly Aphis appeared on the dipped trees until after the pest had established itself in the tops of those trees which had not been dipped. Later the insect was seen floating on the wind and settling on the dipped trees.
9. The results herein recorded have justified further tests of lime-sulfur and whale oil soap, and experiments with these will be conducted in the fall of 1910.

THE OSAGE HEDGE.

While great progress is being made in this State in the elimination of the osage hedges, especially in the great fruit districts, there yet remains miles of this troublesome hedge scattered throughout the State. This hedge is especially abundant and troublesome in the Northern counties.

It was pointed out in bulletin 140 of this station that this hedge plant is a nuisance on any farm, the principal argument for the support of this conclusion being, that the hedge will seldom serve as a proper or satisfactory barrier for domestic animals. It is an expensive fence if properly kept, since trimming is a costly as well as very disagreeable operation.

The osage hedge plant is a very vigorous grower, its roots penetrating the ground on each side of the hedge for at least ten feet and in many cases greater distances. It thus robs the soil of fertility and moisture that should be accessible to crops planted in the field. Lastly, the hedge furnishes abundant food for the San Jose Scale, and serves as a harbor for many other insects pests. It is rare to find an osage hedge of any extent in the State that is not infested with San Jose Scale. It thus serves as a distributing point for the scale by means of birds, etc., to fruit trees in the immediate vicinity.

Enforcement of the Law.

The State Horticultural law requires that all infestations of San Jose Scale be either treated or destroyed. For the protection of the growers in the vicinity, the law is enforced, as far as funds will permit, against neglectful growers, who maintain a few fruit trees which are badly infested with the scale. The law is ridgidly enforced in the inspection of the nurseries in the State. Osage Orange Hedge, therefore, must be considered in the same category, and those who maintain them on their premises must comply with the law by treating or by destroying them.

Considering this condition, the policy has been adopted of allowing farmers three years in which to rid their property of this nuisance. Thus the hedge bordering on the fields to be cultivated each season can be destroyed. This method will not work a hardship on the owner or tenant, and will serve gradually to eliminate this important breeding ground and food plant of the San Jose Scale.

In cases where the owner desires to maintain such a hedge it will be necessary for him to have it annually sprayed for scale. Even in cases where owners adopt the policy of gradually destroying all hedges, if the hedges remaining during this period are in close proximinity to neighbors' orchards, they will be required to treat with an effective remedy once a year.

Treatment of Osage Hedge.

Where the hedge is a standing menace, and circumstances will not permit its being destroyed, it can be sprayed with remedies similar to those employed on fruit trees to control the scale. Any of the lime-sulfur solutions or miscible oils that are effective may be used. Undoubtedly if a large amount of hedge is to be sprayed the use of one of the reliable miscible oils is desirable. There are many small branches to be covered, and as the oil has a greater capacity to spread than the lime-sulfur preparations, and there is no danger of it injuring the plant, the oils are more efficient. Hedges should be sprayed while in the dormant stage, preferably in early spring.

Fortunately Osage Orange hedges that have reasonable attention are not difficult to spray. They are usually cut back to three or four feet, which permits the sprayman to apply the spray, standing on the ground. In spraying a hedge with a barrel pump or power sprayer, it is economical to have two leads of hose, directing the nozzles against each side of the hedge.

PUBLIC SPRAYERS.

The department is continuing the policy of operating public sprayers in different parts of the State, as explained in a previous bulletin from this station. Invariably when a public sprayer is operated in a vicinity for one season it is continued by private parties in that locality thereafter. It seems necessary to start the work in order to demonstrate to those who operate them that there is need for such a business, and that a fair remuneration for honest service is obtainable.

Not only does the public sprayer furnish means for persons living in small towns or suburban districts to have their trees, which are usually prized highly, given proper treatment, but such outfits are available for treatment of small orchards in the vicinity. Many private parties who have been started in this work by the efforts of this department are now conducting power outfits. The demand for work of this character has necessitated the operation of outfits in the fall, as there is not sufficient time to complete their territory in the spring before buds open.

The department is placing public sprayers in operation this fall, but funds will only permit conducting a limited number, the most urgent requests being taken first. All persons thinking that such work is especially needed in their localities should communicate with the State Entomologist, College Park, Md.

CONCLUSION.

There are many fruit trees in the State being injured by the pest, due to ignorance or neglect on the part of the owners. There is no excuse for this condition as the pest can be very successfully controlled by thorough applications of the remedies given in this bulletin. The orchardists have no fear from the pest, but recognize that when given half a chance it will do serious injury to either the life of the tree or to the fruit, making the latter practically unsalable at remunerative prices. There must be a continuous warfare to keep its ravages down to a minimum.

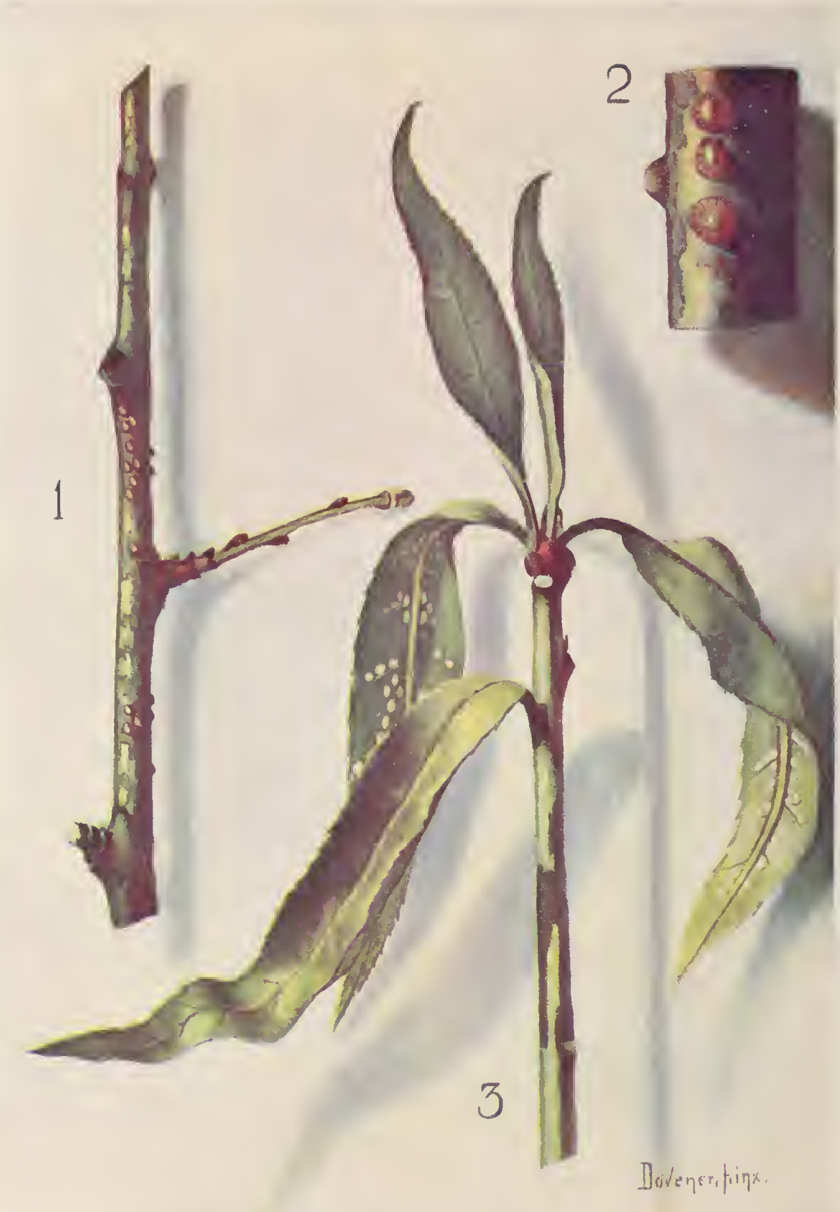

Fig. 1. Immature female scales on peach twig, natural size.
Fig. 2. Immature female scales, enlarged.
Fig 3. Larvae on leaves, natural size.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 149. DECEMBER, 1910.

THE TERRAPIN SCALE.

By T. B. Symons and E. N. Cory.

INTRODUCTION.

The Terrapin Scale *Lecanium nigrofasciatum* (Pergande) has been found in this state for several years, but it has generally been looked upon as an insignificant pest: that is, occurring now and then in unusual numbers on a few trees, but held in check principally through natural agencies, or as many thought by continued applications of the remedy employed against the San Jose' Scale. Not until the season of 1909 was it observed to be a serious pest in several large peach orchards, and then only because of severe losses in the sale of fruit from infested trees, all of which had been sprayed with lime-sulfur wash in early spring. This condition necessitated an investigation of the insect and the employment of tests with different solutions with the hope of securing a satisfactory remedy for its control. The result of the study of this scale insect, the experiments, and its distribution in the state, together with historical references are given in this bulletin.

Brief History And General Distribution.

The Terrapin Scale was first described by Mr. Theo. Pergande in Bulletin No. 18, n. s., Div. of Ent., U. S. Dept. Agri., 1898. Previous to this date, the insect was confounded with Lecanium persicae, an European species. Pergande states that he had known this scale since 1872 when it was discovered upon peach trees at Hillsboro, Missouri. He further remarks, that it spread eastwardly, occurring on peach trees in orchards of the middle, southern, and eastern states, being most abundant and most widely distributed in the state of Maryland.

From these observations, Pergande concludes that the original home of the species points to the region south of New York and north of the Potomac River and from this region it has been distributed through various agencies to all localities where it now occurs.

Sanders, in circular No. 88, n. s., Bureau of Entomology, U. S. Dept. Agri., 1907, states: "From every state east of the Mississippi

River and from Missouri, Arkansas, Louisana, Texas, Minnesota and the Province of Ontario, Canada, the Terrapin Scale has been reported, and authentic specimens have been received by this office." It is thus widely distributed in the East, and may be expected to become injurious in states other than Maryland, where it threatens to become a rather serious pest.

In notes on the insects from Missouri for 1893, Bulletin No. 32, Div. of Ent., U. S. Dept. of Agri., M. E. Murtfeldt, under the read of Lecanium persicae, states, that the insect was reported in injurious numbers on peach and plum trees from several places in that state. She studied the life history of the insect, giving dates of the appearance and measurements of the different stages. From limited tests, she suggests kerosene emulsion, thymocresol, and Cannius fruit protector, as possible remedies.

Sanders, in the circular referred to gives a technical description of this scale insect, its food plants, and recommends kerosene emulsion as the best remedy for the pest.

Several other entomologists in various reports have mentioned the insect occurring from Michigan to Georgia, but in no case has the pest seemed to have been sufficiently important to warrant an extended investigation of the insect, and a study of the best means of control.

Distribution In Maryland.

The earliest record of the first appearance of this scale in this state, is that of Pergande. The first record from this department of its occurrence is that reported by Johnson, in "Miscellaneous Entomological Notes" for 1899, Bulletin No. 20, n. s., U. S. Dept. of Agri. From this date to 1907, it was found now and then in different parts of the state. During the fall of 1906, several cases were reported, principally from Frederick and Washington counties.

In one or two of these orchards, the injury was severe and the department took up a study of the pest, and conducted experiments with different remedies for its control. The result of this work was published in bulletin 123 of this Station by A. B. Gahan. The conclusion reached then was that either insect or fungus parasites or the constant use of lime-sulfur or other remedies employed for the control of the San Jose' Scale would hold this pest in check. Therefore, no further work was done at that time.

During the past two years, however, the Terrapin Scale has spread greatly in the state, both in individual orchards as well as in extending its territory. As far as is known, the most serious outbreaks occurred in Kent, Washington and Anne Arundel counties. In Kent county, at least twelve to fifteen thousand peach trees in different orchards in the vicinity of Still Pond are badly infested with the pest. The orchards present a bad appearance, as the limbs and twigs on the infested trees show black and the ground beneath the trees appear as if soot has been spread over it. This condition exists in several orchards in the vicinity of Smithsburg, Washington County, and Bristol, Anne Arundel County.

The records of this office show that this scale occurs on peach trees in the neighborhood of the following post offices:

Anne Arundel County—Annapolis, Arnold, Bristol.
Baltimore County—Gardensville.
Caroline County—Goldsboro.
Carroll—Westminster.
Charles—Riverside, La Plata.
Cecil—Port Deposit.
Dorchester—Linkwood, Cambridge.
Frederick—Frederick, Johnsville.
Garrett—Grantsville.
Harford—Fallston.
Kent—Still Pond, Worton, Chestertown.
Prince George—College Park, Glendale, Buena Vista.
Talbot—Easton.
Washington—Hagerstown, Smithsburg, Edgemont, Mapleville, Cavetown, Boonsboro.
Wicomico—White Haven.

It is thus seen that the Terrapin Scale occurs now in fifteen counties of the state. If natural enemies do not hold it in check it will probably be second in importance to the San Jose' Scale.

Character Of Injury.

The loss to the orchardist from this scale insect is not so much through the damage to the tree as through the injury to the fruit. The honey-dew, which is excreted in large quantities by the insects, often coats both the leaves and fruit and furnishes an excellent host for a black fungus that renders the fruit practically unsalable at remunerative prices.

The effect of the scale on the trees has not been observed as serious, yet the drain on the trees, caused by the sucking of its juices by the insect, cannot be otherwise than detrimental. The reason for this is that this scale always locates itself on the outer limbs and branches, and while these become stunted, and leaves are dropped, yet there is usually sufficient vigor in the trunk and larger limbs to overcome the injury to the new growth. The ultimate effect on the trees of a very bad infestation, remains to be studied.

Description And Life History.

The Terrapin Scale is one of the soft or naked scales, the outer covering being a hardened portion of the derm and not a wax secretion combined with cast skins, as is the case with the San Jose' Scale.

This scale insect can be most easily identified during its hibernating winter stage. This is shown, approximately natural size on Plate 1, Fig. 1. The scale is hemispherical in form and at this time is about 2 mm. in length and slightly less in width, mottled brown, with radiating streaks of black toward the sides, and an orange red patch on the top, the sides being more or less ridged. Sometimes individuals will be observed to be entirely red or black. Fig. 2 in Plate I shows a much enlarged specimen. As the females develop in spring, the size increases and at full growth the scale is about 3 mm. in length and of nearly uniform reddish brown color.

The Terrapin Scale thus hibernates as an immature female, which reaches maturity about the last of May in this locality, when eggs are deposited under the scale, the body of the mother gradually shrinking as the process of oviposition goes on. When egg laying is finished, there only remains the hard scale covering over the eggs. There is some doubt whether any of the young appear before all the eggs are laid and the female dies. The manner of laying eggs here reported and observations on the occurrence of the different stages correspond very closely with those of Miss Murtfeldt given under Lecanium persicae in Bulletin No. 42, Div. of Ent., U. S. Dept. of Agri.

According to our observations the past year, the first larvae appeared June 4th, and hatching continued for six weeks. The larvae immediately crawled to the leaves and settled along the mid-rib and veins, usually on the under side. Here, the larvae become considerably longer than broad, are translucent, appearing as greenish white spots as illustrated in Fig. 3, Plate I. Development continues on the leaves, the scales remaining here for about six or eight weeks, the males reaching maturity. They fertilize the females which then return and settle permanently on the under side of the smaller twigs and branches. The first record of their return to the twigs is August 13. Here, the females continue to develop through late summer and early fall, wintering as partially mature insects. The scale insect excretes large quantities of honey dew, which serves as a host for the sooty fungus that discolors fruit and foliage.

Food Plants.

So far as observed the Terrapin Scale infests peach, plum maple and apple. Peach seems to be its favorite food plant in this State, although we have found plum trees badly infested. Infested twigs of red maple were sent in from Frederick County and the scales were observed on apple twigs taken from a tree that stood in the midst of a badly infested peach orchard. Sanders reports it occurring on pear, quince, several species of *Crataegus*, Carolina poplar, olive, blue-berry (Vaccinium sp.), Brumelia and spice bush, (Benzoin benzoin). At present the insect can only be considered as a serious pest of peach in this state.

The following statement regarding the parasites of this insect was written by Mr. A. B. Gahan.

NATURAL ENEMIES.

The Terrapin Scale is attacked by a number of natural enemies, the most important of which are minute parasitic wasps *Chalcidoidea.* The eggs of these tiny parasites are deposited in the body of the scale where they hatch, and the larvae or maggots feed upon the body tissues of the scale, finally killing it. The most abundant parasite the past season was *Coccophagus lecanii,* Fitch, specimens of which were reared from practically every lot of Terrapin Scale collected, though seldom in large numbers. Two other species of *Chalcidoidea* were reared in small numbers, viz: *Aphycus stomachosus* Gir., and *Encyrtus* sp. Two specimens *of Aphycus cognatus* Howe, are in the Department collection, reared in 1898, and said to be from this host. In addition to these, Mr. A. A. Girault has recorded from the same host, in Illinois, *Anagyrus nublipennis* Gir. *Coccophagus cinguliventris* Gir., and *Coccophagus longifasciatus* How. (Psyche XVI, p. 75-86).

This scale is also attacked to some extent by Ladybird beetles (*Coccinellidae*), the species most commonly observed being the twice-stabbed ladybird, *Chilocorus bivulnerus.* In Bulletin 123 of this station a fungus disease is mentioned as having been very effective in controlling it. Extended search in many parts of the State since the publication of that bulletin has failed to again locate this fungus.

SPRAYING EXPERIMENTS.

Prior to 1906-07 no extended tests are reported to have been made with a view of seeking the best insecticide for this pest. In fact, in no State had the presence of the insect justified special work. During that year some spraying experiments were conducted with miscible oils and lime-sulfur solutions. These results indicated that both the oils and lime-sulfur solution would control the pest. We discontinued the tests, believing that the practice of annually spraying with lime-sulfur would hold the pest in check. Since that time, however, we have observed that the lime-sulfur has very little, if any, effect on this scale insect, as it has spread enormously in orchards that have been properly treated, annually, with lime-sulfur.

In view of this condition, it was necessary to investigate methods of control, and the following tests were conducted in the fall of 1909 and the spring of 1910. They were rather limited, and had we known of the extent of the infestation as discovered during the past year, special effort would have been made to have extended the work.

The spraying was conducted in the orchards of Mr. A. L. Towson, of Smithsburg; Mr. W. E. Philips, Buena Vista, and Mr. W. F. Chaney, Bristol, all of whom have lost severely from the pest. All trees were badly infested, but otherwise in good condition. At the times of spraying the weather was favorable, making thorough work possible. The thanks of the Department are extended to these gentlemen for the loan of their trees for the expriments, and for the many courtesies extended by them during the test.

A synopsis of the dormant season tests and results secured is given in the following table:

FALL AND SPRING TESTS.

Orchard of A. L. Towson, Smithsburg.

Solution.	Dilution	No. of peach trees per application	Date	Results of fall spraying. March 23, 1910.	Results of double application, June 23 & 28, 1910.	Results of spring spraying, June 23 & 28, 1910.
Soluble Oil.	1-13	12 fall 12 double 9 spring	11/11/09 3/23/10	Killed 90 95 % scale and all fruit buds except 1 tree of an early variety	All scale Killed. Leaf buds O. K.	Practically all scale killed. Buds O. K.
Spray-On.	1-12	19 fall 19 double 5 spring	11/11/09 3/23/10	Killed 50% of scale Buds O. K.	All scale killed. Buds O. K.	35% of scale killed. Buds O. K.
Scalecide.	1-10	17 fall 17 double 4 spring	11/11/09 3/23/10	90 to 95% scale killed. Buds O. K.	Scale twigs and buds killed.	45% scale killed. Buds O. K.
Grassellis Lime-Sulfur	1-8	16 fall 16 double 5 spring	11/11/09 3/23/10	Killed 15% scale. Buds O. K.	No advantage in double spraying over single fall spraying	No scale killed. Buds O. K.
Orchard Brand Lime-Sulfur	1-8	10 fall 10 double 10 spring	11/11/09 3/23/10	Killed 10% scale. Buds all O. K.	No advantage in double spraying over single fall spraying.	No scale killed. Buds O. K.
Soluble Oil	1-20	500	3/21/10			Controlled scale. No buds damaged.
Checks		23		Practically all alive.		

RESULTS.

Soluble oil at the rate of 1 to 13 proved dangerous when sprayed in the fall, but proved very effective in the spring, with no damage to the buds, either in double or single application. At the rate of 1 to 20, sprayed when the fruit buds showed pink, no damage occurred to any trees, and the scale was controlled, though not entirely eradicated.

Spray-On, at the rate of 1 to 12, required a double application in order to be effective. No damage to trees.

Scalecide, at the rate of 1 to 10, sprayed in the fall, proved effective in controlling the scale, and showed no damage to the trees. A double application killed the few remaining scale not hit by the fall application, but killed buds and small twigs. The single spring application killed 45 per cent. of the scale, and did not injure the trees.

The lime-sulfur mixtures prove inefficient in controlling this pest. The results of these tests of lime-sulfur mixtures are supplemented and sustained by the fact that this orchard (as well as others in this State), has been sprayed annually with lime-sulfur, and shows a constant increase in the numbers of scale and the extent of the infestation.

SUMMER SPRAYING.

On August 22nd, 1909, 15 trees badly infested with the Terrapin Scale were sprayed with 10 per cent. kerosene emulsion. Some of the scale on the twigs and leaves were killed, but, owing to the very heavy foliage, the spray could not reach all the insects, and did not kill enough of the larvae, a majority of which were on the leaves, to pay for the effort expended. This treatment was applied in an orchard belonging to W. E. Phillips, Buena Vista.

On June 17th, 1910, two trees were sprayed with .06 per cent. Nico-Sul, and one tree with 10 per cent. kerosene emulsion in the orchard of W. F. Chaney, Bristol. The larvae were crawling in great numbers; eggs under some scales, and a few larvae on leaves. Both sprays killed the crawling larvae, but each evaporated so rapidly that they had no effect on the larvae that hatched subsequently.

On June 23rd, 1910, one tree was sprayed with .20 per cent. Nico-Sul (approximately 1-240); two trees with .10 per cent. Nico-Sul (approximately 1-480), and two trees with 10 per cent. kerosene emulsion in Mr. Towson's orchard. All the solutions killed the larvae that were crawling, but as at Bristol, the mixtures evaporated so rapidly that such spraying was ineffectual. Moreover, in this case, fruit and foliage was injured to a marked degree.

GENERAL SUMMARY OF RESULTS.

Miscible oils that have good spreading power and that, upon evaporation of the water, leave a thorough coating of oil, may be depended upon to control the scale. There seems to be an advantage in spring spraying over fall spraying. This advantage is in the effect on the tree, and it is the experience of the writer that injury may occur at any time to a peach tree sprayed with oil. However, the Terrapin Scale will, when present even in small numbers, make a large percentage of the fruit unsalable, owing to the black fungus that thrives on its excretions. With this fact in view, it seems that it is vastly better to entirely rid an orchard of the scale, even at the expense of one year's crop, rather than allow the pest to continue to thrive, and render a large percentage of the fruit unsalable at remunerative prices.

Lime-sulfur mixtures are totally inefficient for the Control of Terrapin Scale.

Summer spraying to control the pest is impractical. This is due to two factors: the almost certain injury to the fruit and foliage by spraying and the extended period during which the larvae are crawling. This period extended this year from June 4 until June 23 at Smithsburg, and until July 15 at Bristol. During this period eggs, migrating larvae, and larvae on the leaves were found on the same twigs. Solutions evaporated so rapidly that only the crawling forms were killed. Within a half hour of spraying, other larvae appeared upon the twigs, apparently unharmed by the spray.

Recommendations.

From the above results, we recommend that a standard miscible oil be employed at a strength of 1 to 15, applied on the trees just as late in the spring as possible before the buds open.

We believe that such treatment at that time, will be effective in killing the scale and at the same time, be less likely to prove injurious to buds or twigs. We have contended in the past, and believe now, that treating peach trees with oil, may at any time be attended by injury, either to buds or twigs or both; neverless, this is the only treatment that seems available, at this time, and even if some injury to the trees is occasioned, it is better to run the risk that allow the Terrapin Scale to continue to develop in the orchard.

In cases of slight infestation, where only a few trees are affected, it is best to seek out all such trees and treat them with an oil at the rate of 1 to 15. Inasmuch as such an inspection may not discover all cases of infestation, it would seem advantageous to spray the balance of the trees with the same mixture diluted at 1 to 20. This dilution will reduce the possibility of the spread of the scale as well as the likelihood of any injury to buds or twigs from oil.

In cases of infestation of both Terrapin and San Jose' Scale, it is believed that the above treatment is the most practical one to employ, notwithstanding that slight injury from oils on peach is possible. This treatment is suggested as we believe that every effort should be made to rid an orchard of the Terrapin Scale.

Where the peach leaf curl is troublesome, the varieties mostly affected can either be treated with lime-sulfur in the fall, or very early in the spring, the oil spray following just before the buds open. It is believed that such treatment will tend to hold the curl in check and will not interfere with the effectiveness of the oil spray on the Terrapin Scale.

General Remarks.

Spraying orchard trees for this pest should be conducted similarly to treating for San Jose' Scale. Success of the treatment will depend upon the thoroughness of the work. Especially should the under sides of the terminal twigs be hit with the spray. The general principles of spraying and spray pumps which have been discussed so often in previous bulletins applies also in combating this pest. Any one desiring specific information concerning the matter should communicate with the Station.

CONCLUSION.

If the Terrapin Scale continues to spread and increase in the peach orchards where it now occurs, in the same degree in the future as during the past year, we may feel well alarmed as to the injury it will occasion. From the present indications, the greatest vigilance should be maintained to prevent the scale becoming established. Where this pest occurs every effort should be expended to control it. The State Horticultural Law which requires the treatment or destruction of trees or plants infested with injurious insects should apply to this pest to prevent its further spread in the state.

We believe that if growers, having infestations of this scale insect in their orchard, properly apply the remedy suggested, they will not have much difficulty in controlling the pest.

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PIG FEEDING EXPERIMENTS AND TWO KINDS OF HOGHOUSES

By A. L. Stabler.

INTRODUCTION.

The purpose of this bulletin is to report the results of a number of feeding experiments with pigs, and in addition, to describe two styles of hoghouses which this Station now has in use.

Since the publication of the last bulletin relating to hogs eleven experiments in feeding pigs have been conducted, and a growing demand for information on this subject seems to justify a report of these results.

Frequent inquiries about buildings for hogs indicate a desire for information along this line, and as Bulletin No. 63, describing the piggery in use here, is no longer available for distribution, it is deemed advisable to again describe this building.

PART I.

PIG FEEDING EXPERIMENTS.

Description of Feeds.

Except when otherwise noted all feeds used in the following experiments were of good quality. As the names of some of the feeds may not be familiar to all, it is thought advisable to give here a brief description of each feed mentioned.

1. Corn meal, as used in these pages, means the entire corn grain ground.
2. Corn and cob meal means the entire ear of corn ground to meal.
3. Hominy chop is a by-product of the manufacture of hominy and consists of the skin of the corn kernel and the germ ground into a very fine meal. Though somewhat variable in composition, it usually compares favorably with corn meal in composition and palatibility.
4. Gluten meal is another by-product of corn and consists of what remains after taking out the starch, hull and germ. Usually it is in the form of fine granules. It is very concentrated and for pigs should be mixed with some bulky feed.
5. Wheat bran was the grade known as western bran. It was made up almost entirely of the outside skin of the wheat grain.
6. Wheat middlings was also western feed. It was more chaffy than the middlings of the nearby mills.
7. Linseed meal, or linseed oil meal is a by-product of the manufacture of linseed oil from flaxseed, and consists of the oil cake, or

the part remaining after pressing out the oil, ground to meal. There are two kinds, named from the methods of extracting the oil, the "old process" and the "new process" linseed meal. The "old process" meal was used in these experiments. This feed is notably rich in crude protein and fatty matter and is laxative in effect upon the animal.

8. Feeding tankage is a by-product of the slaughterhouses. It consists of the waste parts of the animals, boiled to remove fat, dried and ground. It is very rich in crude protein and in recent years has been proved by experiments to be a valuable supplement to corn in pig feeding.

9. Skim milk was from a centrifugal separator and was fed before it became sour.

10. Ground fodder, which was also known as "the new corn product" and Marsden feed, consisted of the whole corn stalk except the ear and pith. This feed was put upon the market as a substitute for hay.

11. Silage consisted of the whole plants of corn and cowpeas in the same proportion in which they grew in the field. The corn and cowpeas were harvested together and preserved in a silo in the usual manner.

12. Alfalfa hay was well cured and of a good bright grade. Both leaves and stems were used after chopping into about one-quarter inch lengths.

PRICES.

The prices of feed and pork fluctuate very widely from time to time. Consequently, a ration which is very profitable at one time may yield little or no profit at another, due simply to a shift in prices. From this it follows that too much stress must not be laid upon the profitableness of a ration at any certain time. However, for several reasons, brief financial statements have been given for the various tests, and to make general comparison easier uniform prices have been used in figuring profits. The scale of prices is an arbitrary one but represents approximately the relation between the prices of feed and pork which obtained during the early part of 1910 in this vicinity.

The prices used were as follows:

Shelled corn	$28	per ton.
Corn meal	30	" "
Mominy chop	29	" "
Corn and cob meal	24	" "
Wheat bran	28	" "
Wheat middlings	29	" "
Gluten meal	32	" "
Linseed meal, O. P.	40	" "
Corn and cowpea silage	5	" "
Ground fodder	10	" "
Alfalfa hay (chopped)	24	" "
Skim milk	0.25	per cwt.
Feeding tankage	1.75	" "

Hogs were counted worth eight (8) cents per pound live weight.

EXPERIMENT NO. I.

Mixed Grain Feed and Ground Fodder Compared with the Same Grain Feed and Silage.

Where it is practicable, grazing is a factor of recognized value in pork production. Not only does it lower the cost of gains but it also seems to fill a need in the animal economy of the pig, thus improving his general thrift and even the quality of the product. When available, skim milk makes an excellent supplement to corn or mixed grains in a pig ration but often neither pasture nor skim milk is plentiful and sometimes both are unavailable. In such cases the feeder must look to some other source for bulk.

In the present test the aim was to determine the comparative values of ground corn fodder and silage as additions to a grain ration of hominy chop, gluten meal and linseed meal.

The pigs in this trial were Poland China grades purchased for the purpose from a farm nearby. Since weaning, and up to the time the experiment was started, these pigs had been confined in pens and all fed alike upon slop made of ground grain and milk. The pigs were about five months old at the beginning of the test.

Each of the two lots consisted of five pigs selected according to weight. Both lots were housed alike in the Experiment Station piggery upon a cement floor.

These pigs were fed twice daily, receiving the following mixtures:

Lot I.		Lot II.	
Hominy chop..........	300 lbs.	Hominy chop..........	300 lbs.
Gluten meal...........	200 "	Gluten meal...........	200 "
Linseed meal..........	100 "	Linseed meal..........	100 "
Ground fodder.........	100 "	Corn and cowpea silage (all they would eat).	

For Lot I the ground fodder was mixed with the grain and fed in the form of a thick slop. With Lot II the corn and cowpea silage was put in a separate box so that the pigs might eat as much as they wanted.

Table I shows the gains, feed required and the cost for the entire experiment.

March 1st to May 31, 1900. Five pigs in each lot.

	Lot I. Grain and ground fodder.	Lot II. Grain and silage.
Average first weight, lbs.	66.7	66.4
Average last weight, lbs.	119.2	133.6
Average gain, lbs.	52.5	67.2
Average daily gain, lbs.	.573	.730
Feed consumed daily, per pig, lbs.	2.35 grain .39 fodder	2.89 grain .68 silage
Feed for 100 lbs. gain, lbs.	411.0 grain 69.0 fodder	395.0 grain 93.0 silage
Cost of feed for 100 lbs. gain	$6.54 grain $0.34 fodder	$6.28 grain $0.23 silage

It can be seen in Table I that the average gain during the test for Lot I was fifty-two (52.5) and a half pounds and for Lot II was sixty-seven (67.2) and two-tenths pounds. This was a difference in average gain of fourteen (14.7) and seven-tenths pounds in favor of the silage fed lot. As there were five pigs in each lot this was equivalent to a total difference in gains of seventy-three (73.5) and a half pounds. Not only did the pigs in Lot II make more rapid gains but they also required sixteen (16) pounds less grain to produce 100 pounds gain. It is evident from these results that in this test silage proved a more valuable addition to a grain mixture for pigs than did the ground fodder.

TABLE II.

Financial Statement.

Lot I.—			
262.5	lbs. pork at 8 cents		$21.00
1080.	lbs. grain at $1.36 per cwt	$14.69	
180.	lbs. ground fodder at 50 cents per cwt	.90	
	Total cost feed		15.59
	Profit		$5.41
Lot II.—			
336.	lbs. pork at 8 cents		$26.88
1330.	lbs. grain at $1.36 per cwt	$18.08	
313.	lbs. silage at $0.25 per cwt	0.78	
	Total cost feed		18.86
	Profit		$8.02
	Profit Lot I		5.41
	Difference in favor Lot II		$2.61

Table II shows that the lot fed silage made a profit $2.61 greater than the lot fed ground fodder. While small, this margin of profit is by no means negligable when the number of pigs and the size of the investment involved are considered.

EXPERIMENT NO. II.

Shelled Corn vs. Corn Meal.

Probably the most common method of feeding corn to hogs in Maryland is simply to throw the ear corn into the pen at each feed. While practical experience has shown that this method gives good results in a general way, yet the method might not be the most economical one. It might prove profitable to shell the corn before feeding. Still another step would be to grind the corn and feed as meal. In this test only the shelled corn and corn meal are compared. The purpose of the test is to furnish data which will help to answer the question whether it will pay to grind corn for hogs.

The pigs were separated into four lots of five pigs each. Lots I and III received corn meal and skim milk while Lots II and IV received shelled corn and skim milk. Hence, Lots III and IV were duplicates, respectively, of Lots I and II.

The pigs in Lots I and II ranged from 72 to 98 lbs., with an average of 81 lbs., at the beginning of the test, while those in Lots III and IV were from a different source, and ranged from 47 to 72 lbs. with an average of 62 lbs.

As much corn was fed twice daily as the pigs would eat up clean. The quantity of milk fed was not regular but was always equal for all the lots. The corn meal for Lots I and III was mixed with the skim milk and some water and fed as a slop. The shelled corn and skim milk were fed separately to Lots II and IV. With the one exception of preparing the feeds all details of housing and management were as nearly alike as possible for all the lots.

In Table III are shown the weights, gains and feed required, for all lots during the test.

TABLE III.

Experiment No. 2. Lasted 51 days. March 10 to April 30, 1903.
Five pigs in each lot.

Kind of Feed.	Corn meal and skim milk.	Shell'd corn and skim milk	Corn meal and skim milk	Shell'd corn and skim milk
	81.0	81.6	60.3	62.1
Average first weight, lbs.,..	152.5	151.5	132.3	125.2
Average last weight, lbs...	71.5	69.9	72.0	63.1
Average gain, lbs.........	1.402	1.370	1.411	1.237
Average daily gain, lbs....	5.24 gr'n	5.28 gr'n	4.84 gr'n	4.37 gr'n
Feed consumed (	3.34 milk	3.34 milk	3.34 milk	3.34 milk
daily, per pig, lbs.....(	374.0 grain	385.0 grain	343.0 grain	353.0 grain
Feed for (	239.0 milk	244.0 milk	237.0 milk	270.0 milk
100 lbs. gain, lbs......(	$5.61 gr'n	$5.39 gr'n	$5.15 grain	$4.94 gr'n
Cost of feed for (	0.60 milk	0.61 milk	0.59 milk	0.68 milk
100 lbs, gain.........(	$6.21 tot'l	$6.00 tot'l	$5.74 total	$5.62 tot'l

By inspecting Table III it can be noticed that Lot I gained during the whole period seventy-one (71.5) and a half pounds per pig while Lot II gained sixty-nine (69.9) and nine-tenths pounds. This is a difference of only one (1.6) and six-tenths pounds per pig in favor of the corn meal fed lot. In like manner, Lot III gained seventy-two (72) pounds per pig while Lot IV gained only sixty-three (63.1) and one-tenth pounds, a difference of eight (8.9) and nine-tenths pounds per pig in favor of the lot fed corn meal. Lot I required eleven (11) pounds less grain than Lot II to make one hundred pounds gain, and Lot III required ten (10) pounds grain less to make this amount of gain than did Lot IV. These advantages, however, are almost entirely offset by the higher cost of corn meal as compared with shelled corn. From these figures and the financial statement in Table IV it appears that in this experiment there was little difference in economy between shelled corn and corn meal, but this small difference is in favor of the corn meal.

TABLE IV.

Financial Statement.

Lot I—		
357.5 lbs. pork at 8 cents		$28.60
1336.0 lbs. grain at $30 per ton	$20.04	
853.0 lbs. milk at 25 cents per cwt	2.13	
Total cost feed		22.17
Profit Lot I		$6.43
Lot II—		
349.5 lbs. pork at 8 cents		$27.96
1346.5 lbs. grain at $28 per ton	$18.85	
853.0 lbs. milk at 25 cents per cwt	2.13	
Total cost feed		20.98
Profit Lot II		$6.98
Lot III—		
360.0 lbs. pork at 8 cents		$28.80
1235.0 lbs. grain at $30 per ton	$18.53	
853.0 lbs milk at 25 cents per cwt	2.13	
Total cost feed		20.66
Profit Lot III		$8.14
Lot IV—		
315.5 lbs. pork at 8 cents		$25.24
1115.5 lbs. grain at $28 per ton	$15.62	
853.0 lbs. milk at 25 cents per cwt	2.13	
Total cost feed		17.75
Profit Lot IV		$7.49
Total profit from corn meal	$14.57	
Total profit from shelled corn	14.47	
Difference	$0.10	

It should be noted that the smaller and younger pigs in Lots III and IV showed much better gains from the feeding of corn meal than shelled corn while with the larger pigs in Lots I and II the difference was not so marked.

EXPERIMENT NO. 3.

A Comparison of Wet, Soaked and Dry Feeds.

In this test the object was to compare the three methods of feeding, —first, giving the ground grain in the form of a thick slop mixed with water and milk; second, when mixed as above and allowed to soak for twenty-four hours before feeding; and third, giving the ground grain dry and separate from the milk and water.

The pigs were separated into three lots, each lot containing three high grade Poland China pigs and two pure Berkshires. The pigs were selected as to weight and so as to get in every lot the same number from each of three litters. The Poland China grades were about fourteen weeks, and the Berkshires about nine weeks old at the beginning of the experiment. These pigs had all been fed for three weeks previous to starting the experiment upon the same feeds which were used in the test. One of the grade pigs died just before starting the test and it was conducted with only four pigs in this lot. It is evident that Lot II having only four pigs as against five in each of the other lots had slightly more room to exercise and also more space at the trough. How much this affected the gains is not known.

The grain feed, which was the same for all three lots was mixed as follows:

Corn and cob meal......................	300 lbs.
Wheat middlings	100 "
Gluten meal...........................	100 "

It was the aim to feed one pound of skim milk for every pound of grain but the supply of milk was irregular and often none at all could be used.

Each lot was kept in a pen eight by twenty-eight feet on a cement floor. They were fed twice daily. For Lot I the grain and milk were mixed with enough water to make a thick slop and fed immediately. For Lot II, the feed was mixed as for Lot I and then set aside where it would not freeze and allowed to soak for twenty-four hours. Only the quantity that would be used at one feed was mixed at a time. With Lot III the mixture of grains was given dry in a trough. When all or nearly all of this had been consumed the milk and water were mixed and put in the same trough.

In Table V are given the results of this test including the gains, feed required and the cost of same.

TABLE V.

Experiment No. 3. Lasted 112 days. Jan. 1 to Apr. 22, 1905.

Kind of Feed.	Lot I. Wet feed.	Lot II. Soaked feed.	Lot III. Dry feed.
Number of pigs.	5.	4.0	5.0
Average first weight, lbs.	60.5	58.5	60.7
Average last weight, lbs.	130.3	147.0	140.5
Average gain, lbs.	69.8	88.5	79.8
Average daily gain, lbs.	.623	.789	.713
Feed consumed daily, per pig, lbs.	(3.46 grain (1.10 milk	3.71 grain 1.19 milk	3.48 grain 1.04 milk
Feed for 100 lbs. gain, lbs.	(555.0 grain (177.0 milk	470.0 grain 151.0 milk	489.0 grain 146.0 milk
Cost of feed for 100 lbs. gain,	($7.38 grain 0.44 milk ($7.82 total	$6.25 grain 0.38 milk $6.63 total	$6.50 grain 0.37 milk $6.87 total

It appears in Table V that the gain per pig during the trial for Lot II fed on soaked feed was eight (8.6) and six-tenths pounds more than for Lot III fed dry feed and eighteen (18.6) and six tenths pounds more than for Lot I fed wet feed freshly mixed. Lot II consumed daily per pig twenty-three (.23) hundredths of a pound more grain than Lot III and twenty-five (.25) hundredths of a pound more than Lot I. Also, Lot II made 100 lbs. gain for twenty-four cents less than did Lot III and for $1.19 less than Lot I. Hence, in this case, the soaked feed not only made faster gains, but also made cheaper gains than either the dry feed or the freshly mixed wet feed.

TABLE VI.

Financial Statement.

Lot I.—		
349 lbs. pork at 8 cents		$27.92
1939 lbs. grain at $26.60 per ton	$25.79	
617 lbs. milk at 25 cents per cwt	1.54	
Total cost feed		27.33
Profit Lot I		$0.59
Profit per pig		$0.12
Lot II.—		
354 lbs. pork at 8 cents		$28.32
1663 lbs. grain at $26.60 per ton	$22.12	
535 lbs. milk at 25 cents per cwt	1.34	
Total cost feed		23.46
Profit Lot II		$4.86
Profit per pig		$1.22
Lot III.—		
399 lbs. pork at 8 cents		$31.92
1950 lbs. grain at $26.60 per ton	$25.94	
582 lbs. milk at 25 cents per cwt	1.46	
Total cost feed		27.40
Profit Lot III		$4.52
Profit per pig		$0.90

EXPERIMENT NO. 4.

Alfalfa Hay Versus No Hay for Pigs.

In this experiment alfalfa hay was used to add bulk to a grain ration for young pigs. The pigs used were an unusually uniform lot of ten Berkshire grades. They were about ten weeks old when the test started and ranged from 38 to 46 lbs. in weight.

These pigs were separated into two lots of five pigs each. The two lots were fed as follows:

Lot I.		Lot II.	
Shelled corn	5 lbs.	Shelled corn	5 lbs.
Wheat middlings	4 "	Wheat middlings	5 "
Chopped alfalfa	1 "		

Hence, the alfalfa hay fed to Lot I may be considered as displacing an equal weight of middlings in the mixture fed to Lot II.

The feeds were mixed at feeding time with enough water to wet them thoroughly and fed twice daily in a trough. Skim milk, which was fed only during the fourth and fifth weeks of the test, was mixed in with the other feeds. For Lot I it was found difficult to get a uniform mixture of hay and grain when mixed in large quantities. Therefore, to insure getting the proper proportions the hay was added at each feed.

The hay was cut in one-fourth to one-half inch lengths with a small hand cutting-machine and when mixed with the grain was eaten readily by the pigs.

After the test had been running fifty-six days, two pigs in Lot II getting no alfalfa became lame and did not eat well. The lameness was not due to accident but seemed to be a general stiffness of the muscles. As none of the pigs receiving alfalfa in their ration were so affected, it was decided to reject the two sick pigs from Lot II and to continue the experiment.

Therefore, Experiment 4 is divided into two periods. The results of the first period of feeding are given in Table VIIa, while the results of the second period are shown in Table VIIb.

TABLE VIIa.

Experiment No. 4. First period lasted 56 days.

Dec. 2, 1905, to Jan. 27, 1906. Five pigs in each lot.

	Lot I.	Lot II.
Kind of feed.	Shelled corn 5 lbs. Middlings 4 lbs. Alalfa hay 1 lb.	Shelled corn 5 lbs. Middlings 5 lbs.
Average first weight, lbs.,	42.6	42.7
Average last weight, lbs.,	73.2	76.8
Average gain, lbs.,	30.6	34.1
Average daily gain, lbs.,	.546	.609
Feed consumed daily, per pig, lbs.,	2.33 grain .54 milk	2.37 grain .54 milk
Feed for 100 lbs. gain, lbs.,	425 grain 92 milk	389 grain 88 milk
Cost of feed for 100 lbs. gain,	\$5.95 grain \$0.23 milk	\$5.54 grain \$0.22 milk
	\$6.18 total	\$5.76 total

By comparing Tables VIIa above and VIIb below, which represent, respectively, the first and second periods of Experiment No. 4, we find that while during the first period of the trial, when the pigs were young, Lot II without alfalfa gained three (3.5) and a half pounds per pig more than Lot I with alfalfa and made 100 lbs. gain 43 cents more cheaply; yet, during the second period the advantage is reversed, and the gain per pig for Lot I with alfalfa was ten (10.7) and seven tenths pounds greater than for Lot II without alfalfa in spite of the fact that the two culls were taken out of Lot II before the start of the second period. Also, during the second period Lot I made 100 lbs. gain $1.94 more cheaply than Lot II.

TABLE VIIb.

Experiment No. 4. Second period lasted 56 days.

Jan. 27, to Mar. 24, 1906. Lot I has 5 pigs; Lot II has 3 pigs.

	Lot I.	Lot II.
Kind of feed.	Shelled corn 5 lbs. Middlings 4 lbs. Alfalfa hay 1 lb.	Shelled corn 5 lbs. Middlings 5 lbs.
Average first weight, lbs.,	73.2	81.6
Average last weight, lbs.,	111.9	109.6
Average gain, lbs.,	38.7	28.0
Average daily gain, lbs.,	.691	.500
Feed consumed daily, per pig, lbs.,	3.23	2.97
Feed for 100 lbs. gain, lbs.,	467	595
Cost of feed for 100 lbs. gain,	$6.54	$8.48

Tables VIIIa and VIIIb show respectively, the profits and losses made by the pigs during the first and second periods of Experiment No. 4.

TABLE VIIIa. (First Period)

FINANCIAL STATEMENT.

Lot I.		
153 lbs. pork at 8 cents		$12.24
651 lb grain & hay at $28 per ton	$9.11	
150 lb. milk at 25 cents per cwt.,	0.38	
Total cost feed		$9.49
Profit		$2.75
Lot II.—		
170.5 lbs. pork at 8 cents		$13.64
663.5 lbs. grain at $28.50 per ton	$9.45	

150 lbs. milk at 25 cents per cwt	0.38
Total cost feed	$9.83
Profit	$3.81

TABLE VIIIb. (Second Period.)

Financial Statement.

Lot I.

193.5 lbs. pork at 8 cents	$15.48
903 lbs. grain and hay at $28 per ton	12.64
Profit	$2.84

Lot II.

499.5 lbs. grain at $28.50 per ton	$7.12
84 lbs. pork at 8 cents	6.72
Loss	$0.40

EXPERIMENT No. 5.

Hominy Chop Compared with Different Mixtures of Hominy Chop and Wheat Bran.

This experiment was conducted with the object of determining whether hominy chop alone or a mixture of hominy chop and bran is more economical as a feed for pigs, and in some degree, to find what proportion of bran to hominy chop is most suitable.

To this end, twelve pigs were separated into three lots of four pigs each. These lots were fed the mixtures which follow:

Lot I.	Lot II.	Lot III.
Hominy chop 5 lbs.	Hominy chop 4 lbs.	Hominy chop 3 lbs.
	Wheat bran 1 lb.	Wheat bran 2 lbs.

Skim milk was fed to all three lots alike.

Each lot contained two pure Berkshire and two cross-bred Berkshire-Duroc Jersey pigs. At the start of the test the Berkshire pigs were about four months old and the cross-bred pigs were two weeks younger. These pigs ranged in weight from 68 to 112 lbs., with an average of 87 lbs.

They were fed twice daily, in the early morning and again in the evening. The grain feed was mixed with the milk and enough water to make a thick slop and fed fresh.

Table IX shows the weights of the pigs and feed and the costs for this experiment.

TABLE IX.

Experiment No. 5. Lasted 86 days. June 28, to Sept. 22, 1906.

Four pigs in each lot.

Kind of feed.	Lot I. Hominy chop alone.	Lot II. Hominy chop 4 lb. Bran 1 lb.	Lot III. Hominy chop 3 lbs. Bran 2 lbs.
Average first weight, lbs.,	88.1	84.9	87.5
Average last weight, lbs.,	202.0	204.3	181.0
Average gain, lbs.,	113.9	119.4	93.5
Average daily gain, lbs.,	1.324	1.388	1.087
Feed consumed daily,	(4.47 grain	4.50 grain	3.88 grain
per pig, lbs.,	(11.27 milk	11.27 milk	11.27 milk
Feed for	(337 grain	324 grain	357 grain
100 lbs. gain, lbs.,	(851 milk	812 milk	1036 milk
Cost of feed for	($4.89 grain	$4.67 grain	$5.11 grain
100 lbs. gain,	($1.28 milk	$1.22 milk	$1.55 milk
	$6.17 total	$5.89 total	$6.66 total

It can be seen in Table IX that Lot II fed four pounds hominy chop to one pound of bran made a gain during the trial five (5.5) and a half pounds greater than Lot I fed hominy chop alone and twenty-five (25.9) and nine-tenths pounds greater than Lot III getting three pounds hominy chop to two pounds bran. Lot II required thirteen (13) pounds less grain than Lot 1 to produce 100 pounds gain, and thirty-three (33) pounds less than Lot III. Again, Lot II produced 100 pounds gain at twenty-eight cents less cost than Lot I and at seventy-seven cents less cost than Lot III.

These figures tend to show that the substitution of wheat bran for one-fifth the weight of hominy chop increases the value of the ration for pigs, but that hominy chop alone gives better results than a mixture of three pounds hominy chop to two pounds bran.

TABLE X.

Financial Statement.

Lot I.

455.5 lbs. pork at 8 cents		$36.44
1536.5 lbs. grain at $29 per ton	$22.28	
3876 lbs. milk at 25 cents per cwt	9.69	
Total cost feed		$31.97
Profit		$4.47

Lot II.

477.5 lbs. pork at 8 cents		$38.20
1549 lbs. grain at $28.80 per ton	$22.31	
3876 lbs. milk at 25 cents per cwt	9.69	
Total cost feed		$32.00
Profit		6.20

Lot III.

374 lbs. pork at 8 cents		$29.92
1334.5 lbs. grain at $28.60 per ton	$19.08	
3876 lbs. milk at 25 cents per cwt	9.69	
Total cost feed		$28.77
Profit		$1.15

EXPERIMENT No. 6.

Correctives for Pigs.

It is well known among feeders that pigs often crave such substances as wood ashes, charcoal and coal. While it is not known definitely what part these substances play in the life of the pig, yet authorities are practically unanimous in advising the use of some corrective. There are a number of kinds of correctives in use, the most common of which are: wood ashes, charcoal, soft coal, coal ashes, lime and bone meal. Many times salt, sulfur, or both are mixed with one or more of these correctives.

In the present case, it was desired (1) to determine whether soft coal in unlimited quantity is harmful to pigs in confined pens; and (2) to compare the values of soft coal, wood charcoal and a tonic mixture (described later) as correctives for pigs.

Plan of Experiment.

Sixteen pigs were separated into four lots of four pigs each. Lot I had free access to soft coal; Lot II had free access to wood charcoal; Lot III was given for every ten pounds of feed, once ounce of the tonic mixture; and Lot IV was allowed nothing except the grain ration and thus served as a check upon the correctives fed the other lots.

Pigs.

The pigs were high Berkshire grades, taken from four litters. All were sired by the same hog. At the beginning of the experiment they were eleven weeks old, and ranged from 37 to 57 lbs. in weight. All these pigs had received the same treatment previous to the experiment, having been confined in pens since weaning and fed upon ground grain slop. In separating into lots weight was the only guide.

MANAGEMENT.

All lots were confined in similar pens on a cement floor. Feeding took place twice daily, at about 7 A. M. and 5 P. M. The feed was mixed at each feeding time with enough water to thoroughly wet all of it. Care was taken to give all the pigs as much feed as they would eat, so that any effect of the correctives upon the appetites of the pigs might be shown. After feeding, water was put in the troughs, so that the pigs might drink at will. On the whole, the pigs were unusually regular in their habits of feeding and during the entire trial not one pig missed a feed.

FEEDS.

All lots were fed the following mixture of grain:

Corn meal	200 lbs.
Wheat middlings	100 lbs.
Wheat bran	80 lbs.
Linseed meal	50 lbs.

CORRECTIVES.

The correctives were comparatively cheap, and only small amounts were used, yet the cost is by no means small enough to be neglected. Brief descriptions of the correctives used and their cost follow:

Lot I.

Corrective—soft coal, worth $3.25 per ton.

This coal was an ordinary grade used in firing boilers, but did not contain many large lumps.

Lot II.

Corrective—wood charcoal, worth one cent per pound.

This charcoal was made from pine wood and was the grade sometimes used in blast furnaces for smelting iron.

Lot III.

Corrective—for every ten pounds of feed Lot III was fed one ounce of the following mixture:

Wood charcoal	1	lb.	at	1	cent	worth	$0.01
Sulfur	1	"	"	5	"	"	.05.
Common salt	2	"	"	1	"	"	.02.
Bread soda	2	"	"	1	"	"	.02.
Sodium hyposulfite	2	"	"	6	"	"	.12.
Sodium sulfate	1	"	"	3	"	"	.03.
Black antimony	1	"	"	15	"	"	.15.
	—			—			—
	10	"	"	4	"	"	.40

The above ingredients were pulverized and mixed together thoroughly. The formula for this mixture was published several years ago in Farmers Bulletin No. 24 of the United States Department of Agriculture. It was compounded at that time as a cholera preventive, but has since been superseded by more effective treatment. It was selected for this experiment because of its tonic properties.

Table XI shows the results in figures of feeding all four lots during this experiment.

TABLE XI.

Experimnet No. 6. Lasted 77 days. Feb. 12, to Apr. 30, 1909.

Four pigs in each lot.

	Lot I.	Lot II.	Lot III.	Lot IV.
Kind of corrective.	Soft coal.	Wood charcoal.	Tonic mixture.	Nothing (check.)
Average first weight, lbs.,	41.7	41.7	41.6	41.7
Average last weight, lbs.,	95.2	98.5	115.4	89.0
Average gain, lbs.,	53.5	56.8	73.8	47.3
Average daily gain, lbs.,	.695	.738	.958	.614
Feed consumed daily, per pig, lbs.,	2.69	2.61	2.97	2.34
Total feed consumed, lbs.,	830	803	914	722
Total corrective consumed, lbs.,	267	33	8.21	....
Feed for 100 lbs., gain, lbs.,	388	354	310	382
Cost of feed for 100 lbs. gain,	$5.93	$5.42	$4.74	$5.84
Cost of corrective for 100 lbs. gain,	$0.20	$0.14	$0.11	....
Total cost, 100 lbs. gain,	$6.13	$5.56	$4.85	$5.84

Table XI shows that according to rapidity of gains the lots ranked in the following order: first, Lot III, tonic mixture; second, Lot II, charcoal; third, Lot I, soft coal; and fourth, Lot IV, no corrective. Lot III, tonic mixture, also required less grain for 100 pounds gain, thereby producing gains more cheaply, than any of the other lots. It may be noticed that Lot III consumed one hundred (192) ninety two pounds more feed than Lot IV having no corrective.

This was a decided difference in appetite, due apparently to the corrective alone.

Attention is here called to the fact that Lot III was the only one which received any salt besides what may have been contained in the feed. It is probable that this fact has an important bearing on the quantity of feed eaten and the number of pounds gained. However, the comparison between any two of the other three lots is fair, and any difference in gains or costs must be attributed to the difference in correctives fed.

Inasmuch as the pigs getting soft coal ate large quantities of this corrective, and yet had better appetites and gained more pounds than the pigs having no corrective, it would seem that the soft coal was not harmful, in unlimited quantity, but rather beneficial.

TABLE XII.

Financial Statement.

Lot I.

214 lbs. pork at 8 cents		$17.12
830 lbs. feed at $1.53 per cwt	$12.70	
267 lbs. coal at 16 cents per cwt	.43	
Total cost		$13.13
Profit		$3.99

Lot II.

227 lbs. pork at 8 cents		$18.16
803 lbs. feed at $1.53 per cwt	$12.29	
33 lbs. charcoal at 1 cent per lb	.33	
Total cost		$12.62
Profit		$5.54

Lot III.

295 lbs. pork at 8 cents		$23.60
914 lbs. feed at $1.53 per cwt	$13.98	
8.21 lbs. tonic at 4 cents per lb	.33	
Total cost		$14.31
Profit		9.29

Lot IV.

189 lbs. pork at 8 cents per lb	$15.12
722 lbs. feed at $1.53 per cwt	11.05
Profit	$4.07

EXPERIMENT No. 7.

Hopper Feeding—A Preliminary Test.

Palatability probably has an important bearing upon the value of a feed to an animal, but perhaps the appetite is partly controlled by the need of the body for this or that compound contained in the feed. If allowed to choose its own feed, will a pig eat a ration approximating that designated by the feeding standards?

This question induced the feeding of a pen of pigs on hoppers which would furnish several kinds of feed and in such quantities as the appetites of the pigs demanded.

The pigs were five Duroc Jersey sows raised by the Experiment Station. They were more than six months old at the beginning of the test, but ranged between 34 and 59 lbs. in weight, and their appearance showed a lack of normal development.

They were allowed access at all times to corn meal, wheat bran, Armour's feeding tankage and old process linseed meal. Each of these feeds was in a separate hopper. Alfalfa hay in a rack and also wood charcoal were offered at first, but were discontinued because the pigs did not eat them.

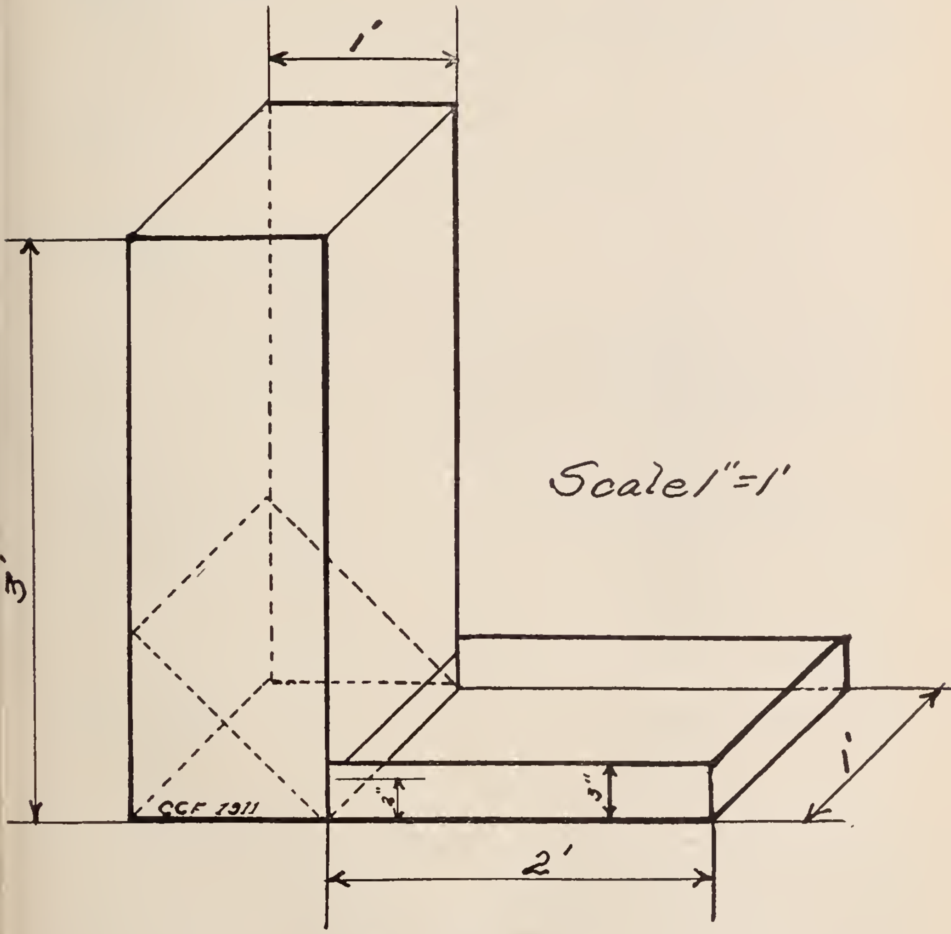


Figure 1.—Feed Hopper.

A drawing of one of the hoppers is shown in Figure 1. This hopper is made of inch boards, and consists of an upright box 1 ft. square by

3 ft. high, with a horizontal box 1 ft. by 2 ft. by 3 in. at the bottom. The upright box holds the supply of feed and the horizontal box is made fast so as to catch the feed as the pig roots it down. The bottom of the upright box is a smooth slanting board which guides all the feed to the outlet. The outlet extends entirely across one side of the upright box, and is about one and a half inches wide, varying slightly with the kind of feed used.

Once each day what feed remained in the hoppers was weighed, and enough added to keep them from getting empty. These pigs did not show any signs of getting "off feed," and did not squeal from hunger. They were noticeably contented and thrifty.

One pig in the lot made a gain of one hundred (160) sixty pounds in seventy (77) seven days, and the total gain for the five pigs was five hundred (580) eighty pounds in the same time.

Table XIII shows the average weights, gains and feed consumed.

TABLE XIII.

Experiment No. 7. Lasted 77 days. Feb. 12, to Apr. 30, 1909.

One lot of five pigs.

Kind of feed.	Free access to corn meal, wheat bran, linseed meal and feeding tankage in separate hoppers.	
Average first weight, lbs.	48.1	
Average last weight, lbs.	164.1	
Average gain, lbs.	116.0	
Average daily gain, lbs.	1.51	
Feed consumed daily, per pig, lbs.	4.73	corn meal.
	.14	bran.
	.32	linseed meal.
	.32	tankage.
	5.51	total.
Feed for 100 lbs. gain, lbs.	314	corn meal.
	9	bran.
	22	linseed meal.
	21	tankage.
	366	total.
Cost of feed for 100 lbs. gain	$4.71	corn meal.
	$0.13	bran.
	$0.44	linseed meal.
	$0.37	tankage.
	$5.65	total.

Table XIII shows that this lot of pigs fed with hoppers and allowed to eat as much as they wanted of all the four feeds; corn meal, wheat bran, linseed meal and feeding tankage, made an average daily gain of one (1.51) and fifty-one hundredths pounds.

By looking at the daily consumption of feed we see that the pigs ate much more of the corn meal than of all the other feeds combined. These pigs made very satisfactory gains for feed consumed, requiring a total of only three hundred (366) sixty-six pounds of feed to make 100 lbs. gain.

It is worth noting how regular these pigs were in their habits of feeding. To illustrate this point part of the actual daily record of feed eaten is shown in Table XIIIa.

This table shows the amounts of feed eaten during the middle three weeks beginning with the fifth week of the experiment.

Table XIIIa.

Daily Feed Record in Pounds.

1909.		Corn meal.	Wheat bran.	Linseed meal.	Tankage.
March	13	23.00	.75	2.00	1.50
	14	23.00	.75	2.00	2.25
	15	28.75	.25	1.75	2.25
	16	24.50	.00	2.50	2.25
	17	25.50	.25	2.25	2.25
	18	24.00	1.00	1.50	2.00
	19	23.50	.75	.50	1.75
	20	24.75	.75	1.75	1.25
	21	25.75	.25	1.75	2.00
	22	21.75	.25	1.75	1.50
	23	24.25	.00	1.75	1.25
	24	25.50	.00	1.25	1.50
	25	24.25	.00	1.25	1.25
	26	26.50	.50	1.00	1.00
	27	24.00	.25	1.50	1.50
	28	22.25	.00	1.25	1.25
	29	24.00	.00	1.25	1.50
	30	25.00	.12	1.75	1.75
	31	28.25	.13	2.00	1.75
April	1	25.00	.00	1.25	1.75
	2	25.25	.00	1.50	1.25

The amounts of feed eaten during the three weeks shown in Table XIIIa may be regarded as about the average for the whole experiment. During the previous four weeks the amounts were smaller and during the four weeks following the quantities were considerably larger. Bran was the only feed of which the pigs ever failed to eat some for a day. The greatest variation between the amounts of corn meal eaten on any two successive days during the three weeks shown was five (5.75) and seventy-five hundredths pounds, which divided by five would be one (1.15) and fifteen hundredths pounds for each pig. While the amounts of linseed meal and tankage consumed were never very large, yet some of these feeds were always eaten during the day.

Table XIIIb shows the chemical composition of the feeds used as analyzed by Mr. L. B. Broughton in the Experiment Station laboratory.

TABLE XIIIb.

Chemical Composition of Feeds Used.

Name of feed	Water	Ash	Crude protein	Fiber	N-free extract	Fat
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Corn meal	12.97	1.55	8.75	2.27	69.19	5.27
Wheat bran	9.75	6.45	13.87	11.43	52.05	6.45
Linseed meal	8.83	4.80	34.12	7.38	38.32	6.55
Tankage	6.30	32.82	35.06	4.60	7.70	13.52

The digestibilities of feeds in Table XIIIc are taken from Henry's "Feeds and Feeding", 10th Ed., p. 581.

The digestibilities used for the dry matter, crude protein and fat in the tankage are those given for flesh meal. The digestibilities of fiber and nitrogen-free extract are assumed.

TABLE XIIIc.

Numerical Coefficients of Digestibility.

Name of feed	Dry matter	Crude protein	Carbohydrates Fiber	Carbohydrates N-free extract	Fat
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Corn meal	90	88	39	94	80
Wheat bran	66	75	34	66	72
Linseed meal	77	86	12	85	80
Tankage	92	97	15	80	87

The amounts of digestible nutrients fed, found by multiplying the amount of a nutrient in one pound of feed, as shown in an analysis (Table XIIIb), by the numerical coefficient of digestibility (Table XIIIc) and this product by the number of pounds of feed given the animal, are shown in Table XIIId.

TABLE XIIId.

Digestible Nutrients in Feed Consumed.

Name of feed	Amount fed	Dry matter	Crude protein	Carbohydrates		Fat
				Fiber	N-free extract	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Corn meal	4.73	3.704	.364	.421	3.075	.189
Wheat bran	.14	.083	.015	.005	.048	.006
Linseed meal	.32	.225	.094	.003	.104	.017
Tankage	.32	.276	.109	.002	.026	.038
	5.51	4.228	.582	.431	3.253	.250
Standard ration		3.500	.500		2.310	.080

The nutritive ratio of the above ration is 1 :7.3.

TABLE XIV.

Financial Statement.

Experiment No. 7. One lot.

580 lbs. pork at 8 cents		$46.40
1823 lbs. corn meal at $30 per ton	$27.35	
53 lbs. bran at $28 per ton	.74	
125 lbs. linseed meal at $40 per ton	2.50	
122 lbs. tankage at $35 per ton	2.14	
Total cost feed		32.73
Profit		$13.67

EXPERIMENT No. 8.

Hopper Versus Grinder—First Test.

Wishing to test the efficiency of the "Hog Motor Grinder and Feeder", a machine that is upon the market, this test was arranged to feed one lot with the "grinder" and another lot with the hopper described in Experiment No. 7. Thus, the pigs in one lot were eating corn meal which they ground for themselves while those in the other lot were eating shelled corn. In addition to the corn each lot was fed wheat middlings and separator skim milk in a trough. The aim was to give the hopper fed lot as much middlings as they would clean up in addition to the shelled corn. Skim milk was fed as available but was always limited in quantity. Lot II on the Grinder was fed the same quantity of middlings and the same quantity of milk as Lot I on the hoppers. All conditions, then, were the same for the two lots except the method of feeding the corn.

The corn used was of inferior quality and is rated at three fourths the usual price.

The pigs were allowed access to wood charcoal and rock salt throughout the experiment.

The pigs were all from one litter and were uniform and thrifty. They were half-bred Duroc Jerseys, their dam being of unknown breeding. These pigs were nearly four months old at the beginning of the test. Previous to the experiment they had run on blue grass pasture with some grain in addition.

Table XV shows the weights, gains, feed consumed and costs for Experiment No. 8.

TABLE XV.

Experiment No. 8. Lasted 75 days. July 1 to Sept. 14, 1909.
Four pigs in each lot.

	Lot I. Hopper.	Lot II. Grinder.
Average first weight, lbs.	95.6	96.5
Average last weight, lbs.	234.7	220.7
Average gain, lbs.	139.1	124.2
Average daily gain, lbs.	1.85	1.65
Feed consumed daily per pig, lbs.	4.76 corn 1.27 middlings 6.31 milk	4.04 corn 1.27 middlings 6.31 milk
Feed for 100 lbs. gain, lbs.	256 corn 68 middlings 339 milk	244 corn 76 middlings 385 milk
Cost of feed for 100 lbs. gain	$2.69 corn $0.89 middlings $0.85 milk	$2.56 corn $1.02 middlings $0.96 milk
	$4.43 total	$4.54 total

It can be seen in Table XV that while both the hopper and grinder gave good results, the pigs fed with the hopper consumed more feed, made faster gains and made more gain for a given amount of feed.

The financial statement in Table XVI will serve to show the difference in profits for the two methods.

TABLE XVI.

FINANCIAL STATEMENT.

Lot I.—HOPPER.

556.5 lbs. pork at 8 cents		$44.52
1429 lbs. corn at $21 per ton	$15.00	

380 lbs. middlings at $29 per ton	5.51	
1892 lbs. milk at 25 cents per cwt	4.73	
Total cost feed		25.24
Profit		$19.28

Lot II.—Grinder.

497 lbs. pork at 8 cents		$39.76
1213 lbs. corn at $21 per ton	$12.74	
380 lbs. middlings at $29 per ton	5.51	
1892 lbs. milk at 25 cents per cwt	4.73	
Total cost feed		22.98
Profit		$16.78

EXPERIMENT NO. 9.

Hopper Versus Grinder—Second Test.

This experiment was planned to compare further the merits of the Hog Motor Grinder and Feeder and the hopper used in Experiment No. 7. Experiment No. 9 differs from experiment No. 8 in one respect, —corn meal was fed in the hoppers instead of shelled corn. The corn meal fed in the hopper was ground from the same corn that was fed in the grinder.

The pigs were from a single litter and were cross-bred Duroc Jersey-Berkshires. They were nearly five months old when the test started. These pigs had been raised mainly on blue grass pasture with middlings slop and some corn. They always had access during the experiment to rock salt and soft coal.

The same grade of corn was used as in Experiment No. 8; therefore the shelled corn is rated at $21 and the corn meal at $23 per ton Weights, gains, feed and costs will be found in Table XVII.

TABLE XVII.

Experiment No. 9. Lasted 35 days. Oct. 1 to Nov. 4, 1909
Four pigs in each lot.

	Lot I. Hopper.	**Lot II. Grinder.**
Average first weight, lbs.	101.0	100.7
Average last weight, lbs	174.7	165.9
Average gain, lbs.	73.7	65.2
Average daily gain, lbs.	2.11	1.86
Feed consumed daily per pig, lbs.	6.06 corn 1.49 middlings	5.07 corn 1.49 middlings

Feed for 100 lbs. gain, lbs.	287 corn 71 middlings	273 corn 80 middlings
Cost of feed for 100 lbs. gain,	$3.30 corn $1.02 middlings	$2.86 corn $1.16 middlings
	$4.32 total	$4.02 total

TABLE XVIII.

FINANCIAL STATEMENT.

Lot I.—HOPPER.		
295 lbs. pork at 8 cents		$23.60
848 lbs. corn at $23 per ton	$9.75	
209 lbs. middlings at $29 per ton	3.03	
Total cost feed		12.78
Profit		$10.82
Lot II.—GRINDER.		
260.5 lbs. pork at 8 cents		$20.84
710 lbs. middlings at $29 per ton	$3.03	
209 lbs. corn at $21 per ton	7.45	
Total cost feed		10.48
Profit		$10.36

By observing Tables XVII and XVIII we may see that Lot I fed with a hopper consumed more feed, made faster gains, and, notwithstanding the facts that the pigs fed with the grinder produced 100 lbs. gain more cheaply and that Lot I was charged more for feed the margin of profit was slightly on the side of the hopper. This is an instance where number of pounds gained counts more towards total profits than the relative cost of producing one pound gain.

EXPERIMENT NO. 10.

HOPPER VERSUS TROUGH—FIRST TEST.

This test was planned in order to compare the ordinary method of slop feeding in a trough with the hopper feeding.

The pigs were cross-bred Berkshire-Duroc Jerseys selected from four litters of about the same age. These pigs were about five months old at the beginning of the experiment and had been confined in pens and fed on soaked corn and middlings since weaning at about two months of age.

Two lots of five pigs each were fed identical mixtures of feed, the difference between the lots being in the manner in which the feed was given. Lot I, on hoppers, had dry feed always before them. Lot II was fed twice daily in a trough and their feed was made into a slop. Both lots had water always before them.

The feed consisted of the following mixture:

Corn meal.................	200 lbs.
Wheat middlings...........	300 "
Wheat bran................	100 "

Both lots were given access to rock salt and both lots had all the soft coal they would eat until May 17th, after which no coal was fed.

TABLE XIX.

Experiment No. 10. Lasted 63 days. April 4, to June 6, 1910.
Five pigs in each lot.

	Lot I. Hopper.	Lot II. Trough.
Average first weight, lbs.	82.9	83.3
Average last weight, lbs.	127.8	129.4
Average gain, lbs.	44.9	46.1
Average daily gain, lbs.	.71	.73
Feed consumed daily per pig, lbs.	3.71	3.50
Feed for 100 lbs. gain, lbs.	520	478
Cost of feed for 100 lbs. gain	$7.58	$6.97

TABLE XX.

Financial Statement.

Lot I.—Hopper.	
224½ lbs. pork at 8 cents...........................	$17.96
1168 lbs. grain at $29.16 per ton........................	17.03
Profit	$0.93
Lot II.—Trough.	
230½ lbs. pork at 8 cents...........................	$18.44
1101 lbs. grain at $29.16 per ton........................	16.05
Profit	$2.39

EXPERIMENT NO. 11.

Hopper versus Trough—Second Test.

This test was conducted in order to get more data comparing hopper feeding with the ordinary slop feeding method.

Two lots of five pigs each were fed the same ration, Lot I being fed only dry feed by means of the hoppers and Lot II being fed only slop in a trough.

Each lot contained three cross-bred Duroc Jersey-Berkshire pigs and two Duroc Jersey pigs. They were all from two litters and were about three and a half months old when the test began.

Previous to the experiment these pigs had run on blue grass pasture and had been fed mainly on middlings with some corn meal. They were in medium flesh when put on experiment.

The ration fed consisted of equal parts by weight of hominy chop and middlings. It was the intention to feed two pounds of skim milk for each pound of grain fed Lot II, and to feed Lot I an equal weight of skim milk. However, no milk was fed after the first seventeen days because it was no longer available.

While being fed, the skim milk was mixed with the grain for Lot II, but was fed alone in a trough to Lot I. Both lots had as much water as they would drink. Both lots had rock salt before them at all times.

TABLE XXI.

Experiment No. 11. Lasted 64 days. June 29 to August 31, 1910.
Five pigs in each lot.

	Lot I. Hopper.	Lot II. Trough.
Average first weight, lbs.	58.0	58.4
Average last weight, lbs.	138.4	145.4
Average gain, lbs.	80.4	87.0
Average daily gain, lbs.	1.26	1.36
Feed consumed daily per pig, lbs.	4.85 grain 6.73a milk	4.72 grain 6.73a milk
Grain for 100 lbs., gain lbs.	387.00	348.00
Cost of grain for 100 lbs. gain	$5.71	$5.13

a. Refers to the first seventeen days only.

TABLE XXII.

FINANCIAL STATEMENT.

Lot I.—HOPPER.

402 lbs. pork at 8 cents		$32.16
1554 lbs. feed at $29.50 per ton	$22.92	
572 lbs. milk at 25 cents per cwt	1.43	
Total cost feed		24.35
Profit		$7.81

Lot II.—TROUGH.

435 lbs. pork at 8 cents		$34.80
1512 lbs. feed at $29.50 per ton	$22.30	
572 lbs. milk at 25 cents per cwt	1.43	
Total cost feed		23.73
Profit		$11.07

One point should be noted in connection with Experiments Nos. 10 and 11. The dry feeding in the hopper requires less labor than the slop feeding. In practice a hopper could be filled with feed and visited just enough each day to insure a proper flow of feed. Also, the hopper feeding removes the danger of getting "off feed" which will often be experienced in slop feeding with a careless attendant.

GENERAL DISCUSSION.

It may occur to some readers that the financial returns from the hog feeding in these experiments were not large. It should be realized, however, that only the feeder's profit is allowed; while usually a man in the business of producing pork for market gets a profit on the feed raised on the farm when the hogs pay market price for it, and again, he gets the breeder's profit, or the difference between the cost of raising a pig to weaning age and the selling price at that time.

Another way in which the hog makes a profit for his owner is by paying a much better return for feed of inferior quality than could be obtained by the sale of this feed. Some persons seem to think that the main purpose of the hog is to utilize wastes and unsalable products. It is often a good practice to feed hogs upon such substances, but there is no good reason for confining the hog industry to producing hogs in this manner if they will pay a profit upon other and more valuable feeds. While in the experiments in this bulletin the main aim was not to make large profit, but rather to make fair comparisons under existing conditions, yet it should be noted that nearly every test proved profitable with the first quality feeds used.

Another point not to be lost sight of, is that the hog removes a minimum amount of fertilizing material in the carcass and leaves a maximum amount in the manure.

If it were possible to persuade a large number of men to go into the hog raising business probably a large percentage of them would fail besides hurting the profits of the men who were already in the work. Yet, it is believed that many more hogs could be raised to advantage in Maryland than at present. The appeal, however, is not so much for more hogs, but for better hogs, and, especially, for better methods of feeding and management.

Summary.

1. Pigs allowed silage at will made faster and more economical gains than those having ground fodder mixed with their feed.

2. Young hogs made faster gains upon corn meal and skim milk than upon shelled corn and skim milk, but if cost of grinding was subtracted the difference in profit was small though still in favor of corn meal as against shelled corn.

3. Pigs fed a mixture of grains soaked for 24 hours made both faster and cheaper gains than either pigs fed the same feed mixture dry, or those having it given freshly mixed with water.

4. Pigs fed for a period of 56 days on a ration consisting of shelled corn, wheat middlings and skim milk grew faster than those having chopped alfalfa substituted for part of the middlings in the above ration. When the test was continued, rejecting two sick pigs from the lot without alfalfa, the pigs getting alfalfa gave the better results.

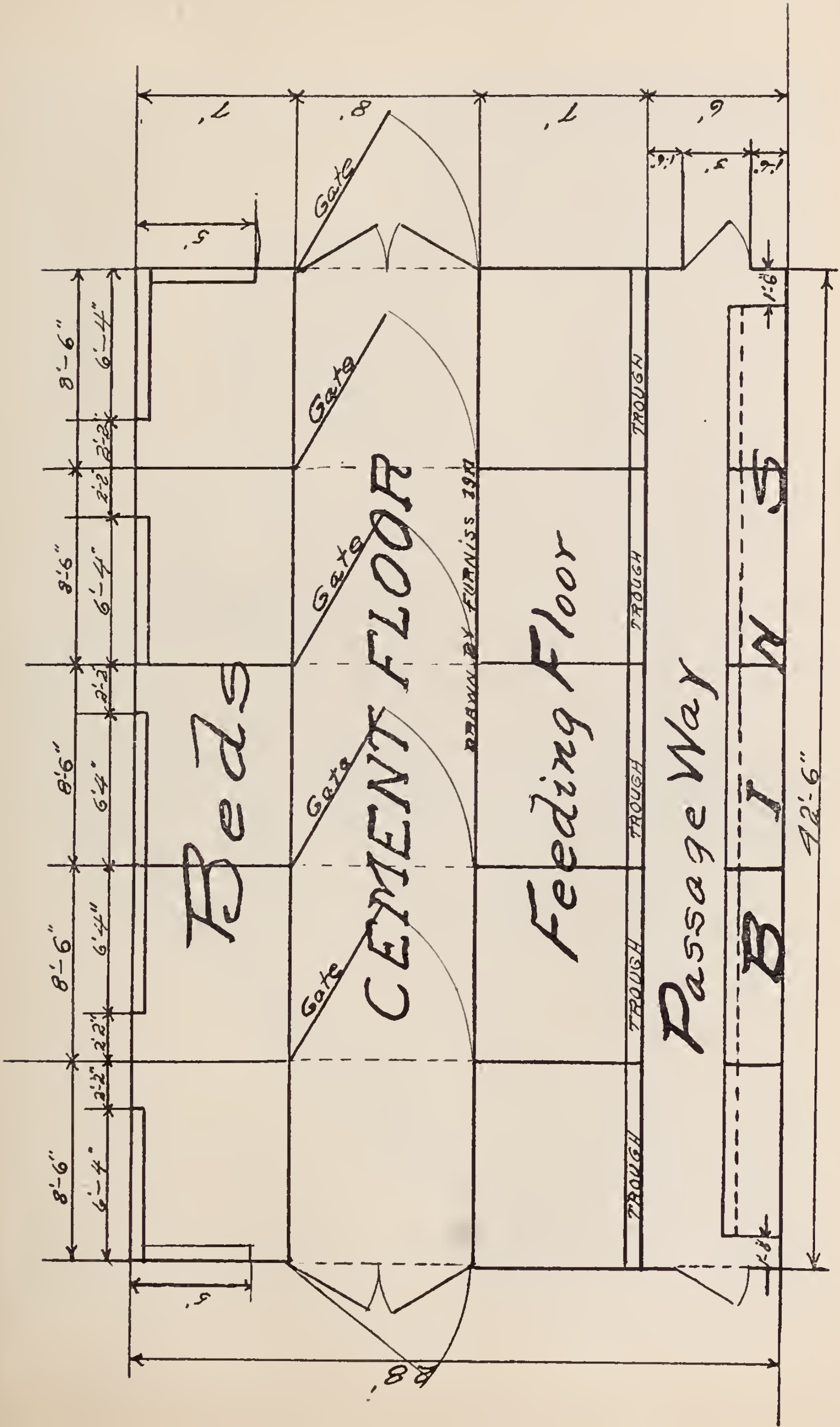
5. The substitution of wheat bran for one-fifth the weight of hominy chop increased the value of the ration but hominy chop alone gave better results than a mixture of three pounds hominy chop to two pounds bran.

6. Soft coal in unlimited quantity seemed not to be harmful to pigs in confined pens. Soft coal, wood charcoal and a tonic mixture ranked according to value as correctives in the following order: (1) tonic mixture (2) wood charcoal, (3) soft coal. The lot of pigs having no corrective made smaller gains than any of the other lots, but produced pork more cheaply than the lot on soft coal.

7. Five pigs allowed to eat as much as they wanted of four different feeds made good gains, ate regularly without surfeiting and produced pork economically. The nutritive ratio of the voluntary ration they consumed was 1:7.3.

8 and 9. The Hog Motor Grinder and Feeder gave good results in two tests. However, when used in comparison with hopper feeding of both shelled corn and corn meal the margin of profit was in favor of the hopper-fed pigs.

10 and 11. In two tests ordinary slop feeding gave better results than hopper feeding if no allowance was made for difference in labor or danger of the pigs surfeiting on slop.



Figue 2.—Floor-plan Scale 1/8"=1'.

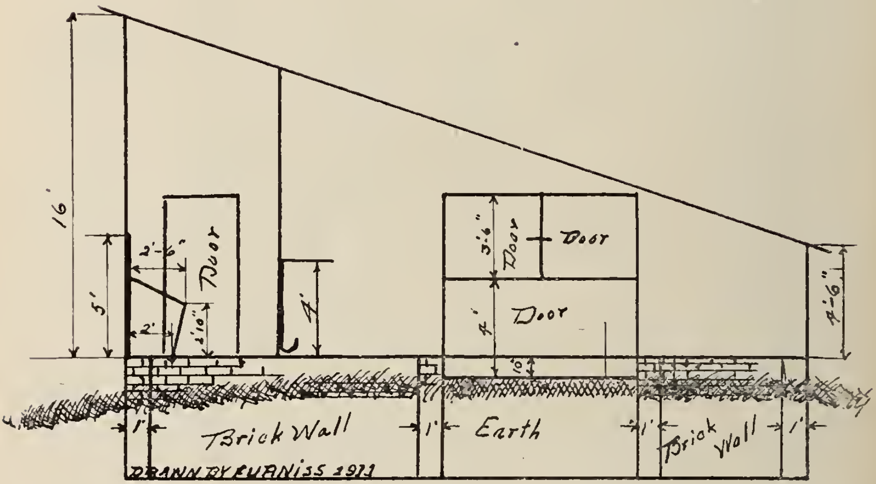


Figure 3.—End Elev. Scale ⅛"=1'.

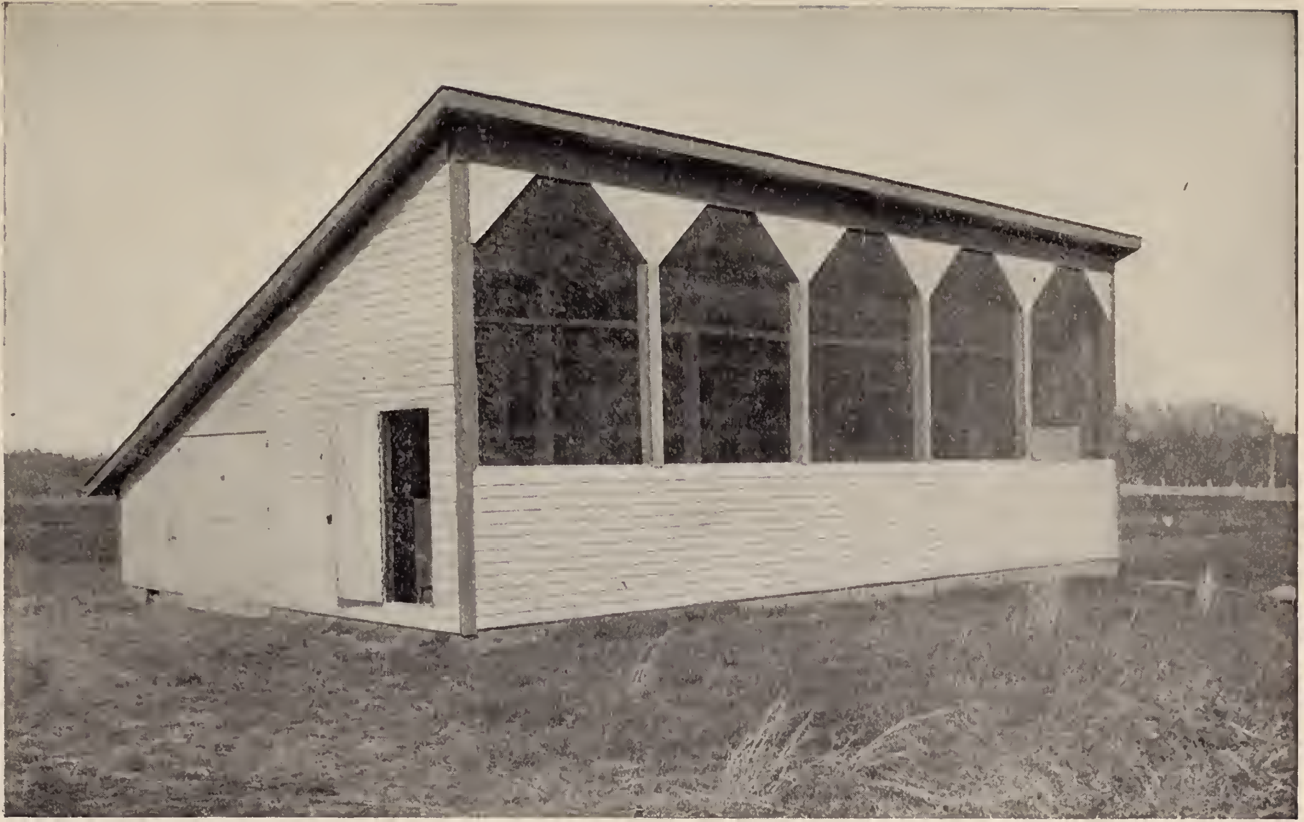


Figure 4.—Hog House—view from S. W. (Bul. 63.)

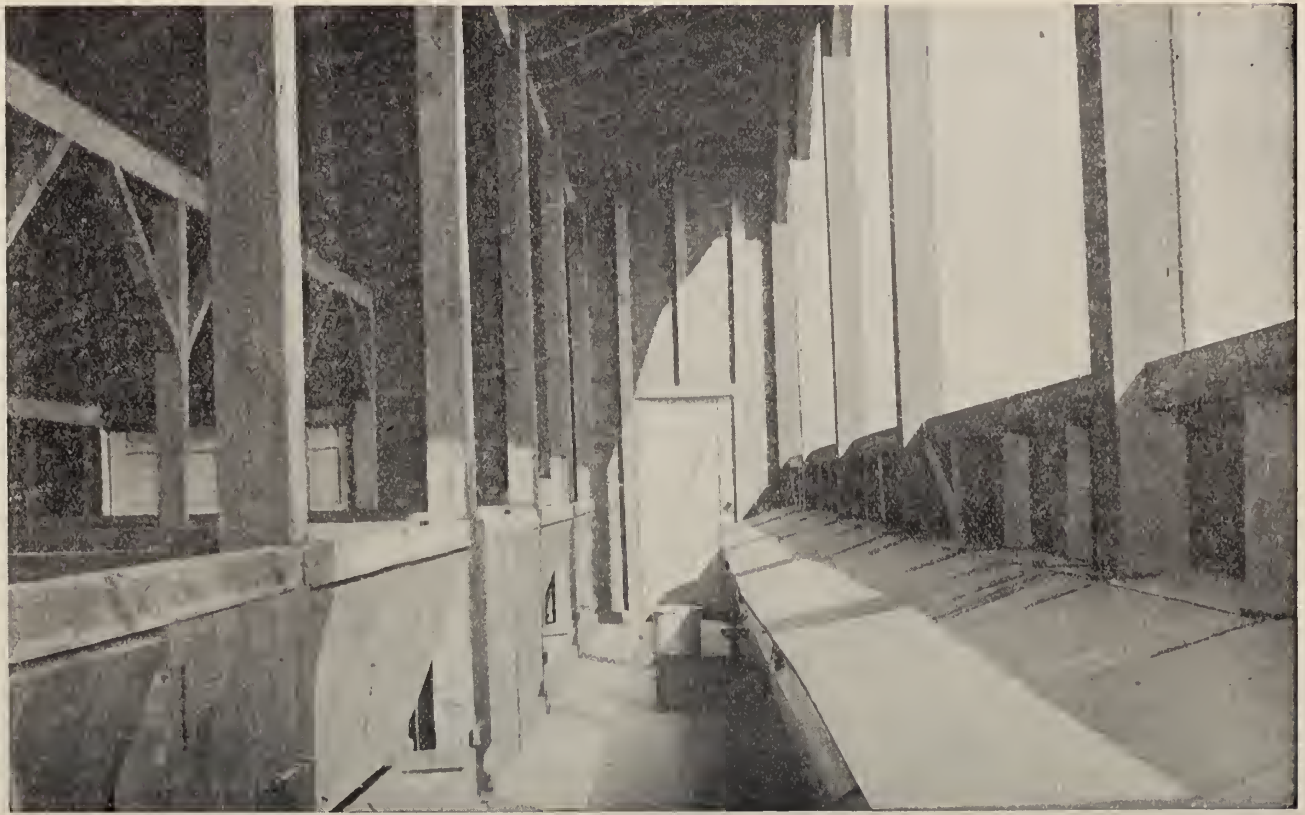


Figure 5.—Hog House—Interior view showing feed bins and feeding alley. (Bul. 63.)

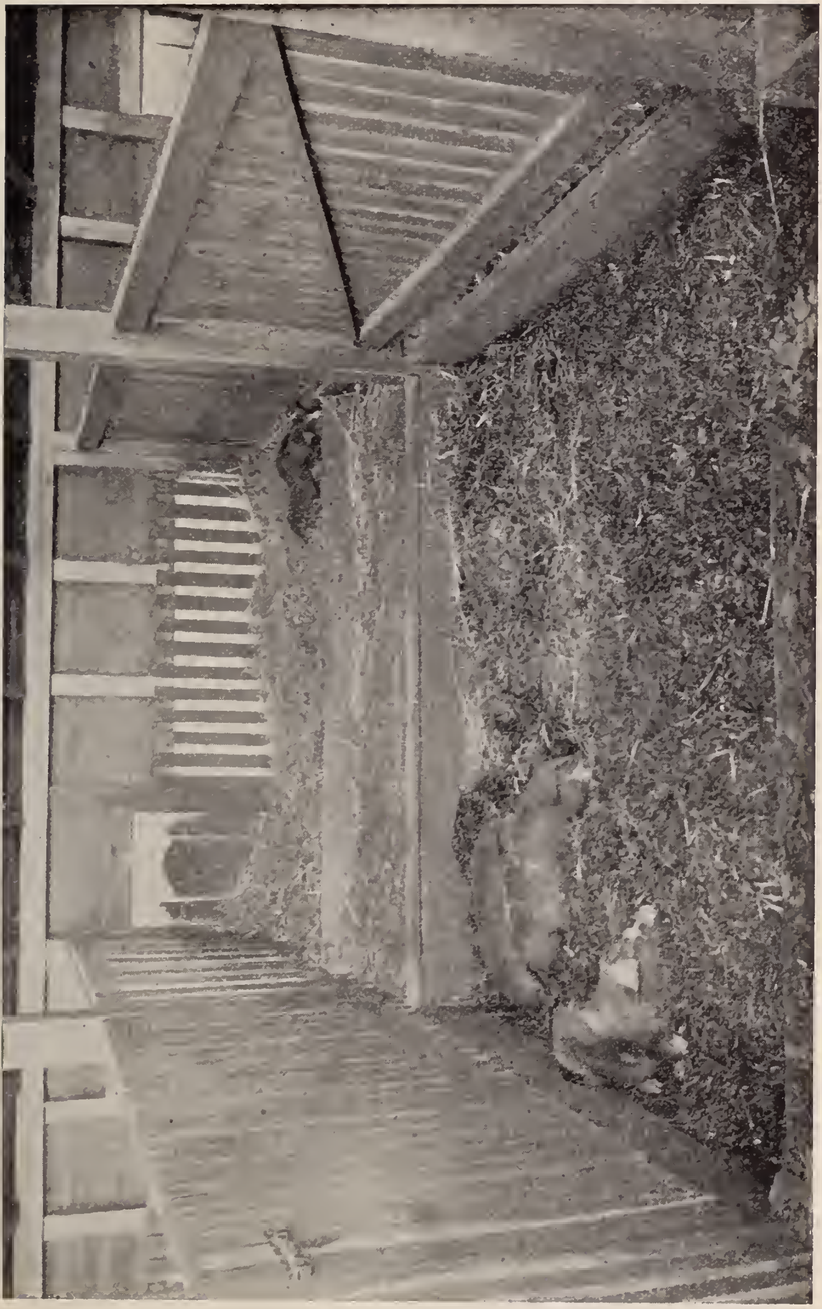


Figure 6.—Hog House—Interior view showing bed in rear of pen. (Bul. 63.)

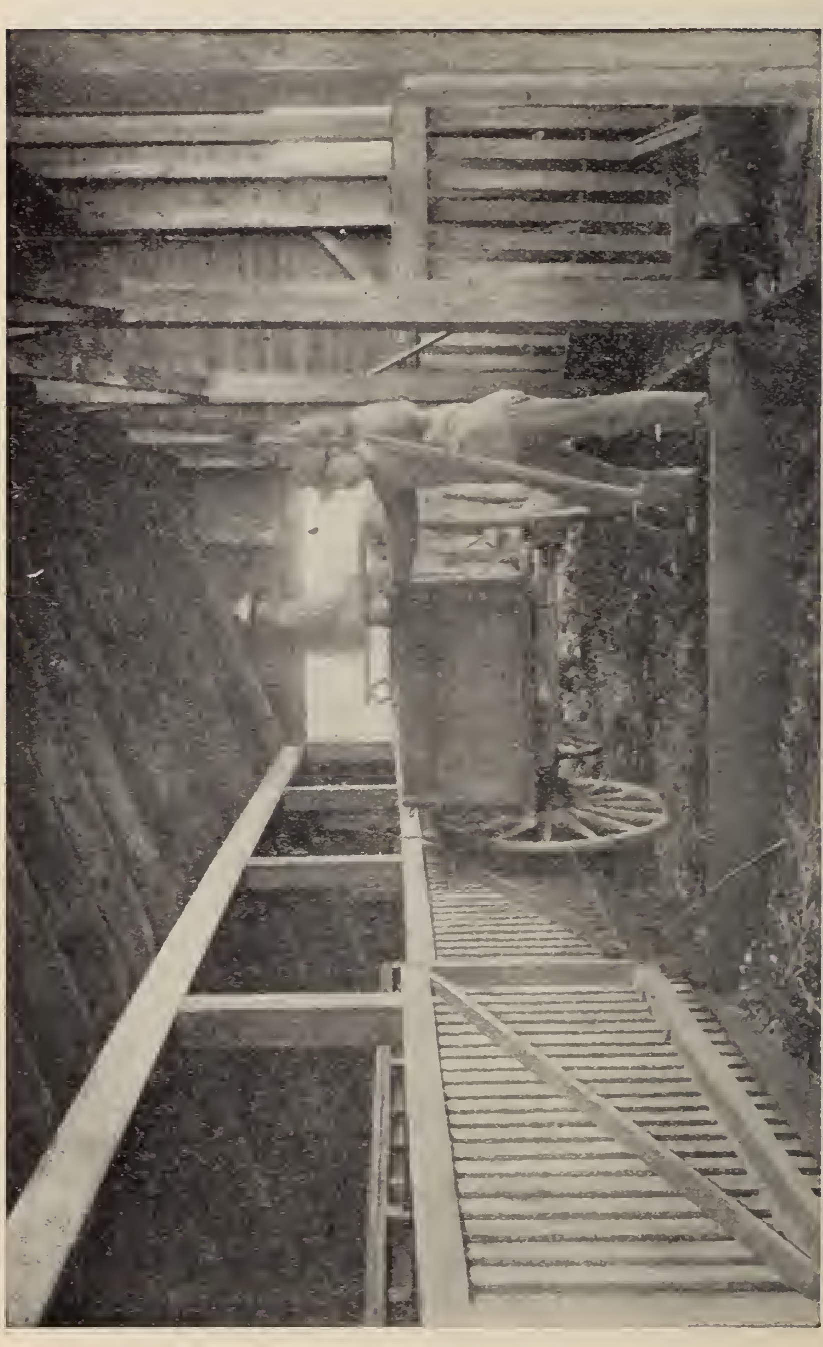
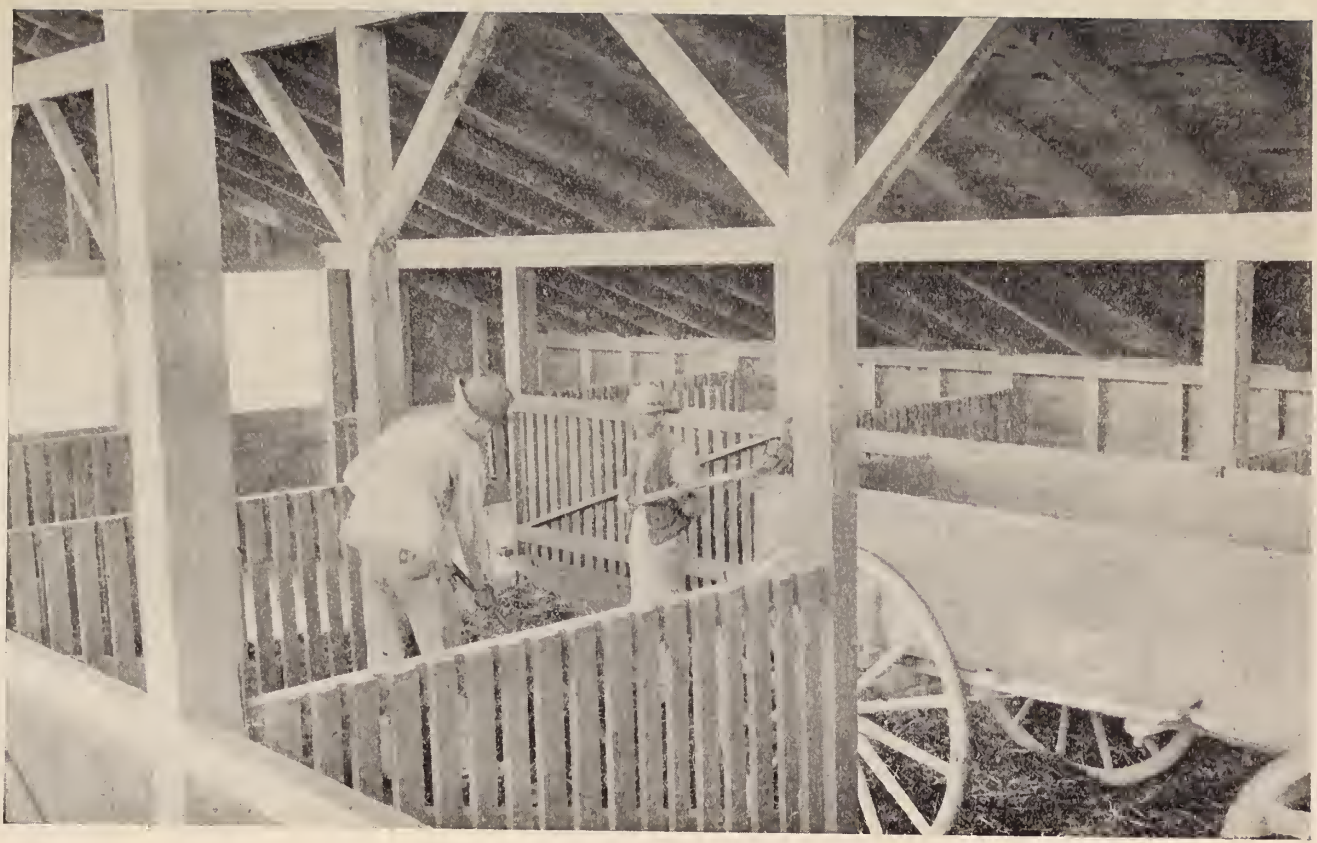


Figure 7.—Hog House—Interior view showing method of driving into the pen for the manure. (Bul. 63.)



(Bul. 63.) Figure 8.—Hog House—Interior view showing wagon in place for loading manure.

PART II.

DESCRIPTION OF TWO TYPES OF HOGHOUSES.

The Maryland Station Hoghouse.

This building is designed as a place to house and feed hogs at any season of the year. It consists of five pens of equal size, a feeding aisle and five feed bins. This hoghouse is open to the south and has a roof of single slope or a shed-roof.

Each pen is made up of three parts made by different levels of the floor. The central part is a manure pit which is ten inches lower than the rest of the floor. The south division of the pen is a feeding floor with a trough across the end while the north division is the sleeping floor or bed. The entire floor of the building is cement except the feed bins and the sleeping floor.

The frame is made of the following pieces:

Sills	6" x 6"
Main posts	6" x 6"
Intermediate posts	3" x 4"
Braces	3" x 4"
Plates	4" x 6"
Purloins	2" x 8"
Rafters	2" x 6"
Joists	4" x 6"

This frame is made heavy in order to support the slate roof. The floor in the beds is made of oak plank 2"x12". The partitions between pens, including the gates, are 1"x2½" slats 2" apart nailed on 2"x4" cross-pieces. Under each gate is a movable 2"x12" oak plank as partition in manure pit. The sides of the building are made of a single thickness of ⅞"x5" German or Novelty siding. The front is boarded up five feet above foundation and covered with inch-mesh wire from this height to the roof. The troughs are of iron.

The dimensions[a] of this piggery will be found in Figs. 2 and 3, while the arrangement for feeding and cleaning pens and the plan of minor parts of equipment may be seen in Figs. 2 to 8.

[b]"It may be well to enumerate a few of the special points in construction" and some of the advantages of this piggery.

"1st. It is faced to the south so as to permit the rays of the sun to shine upon the beds of the pigs at the extreme rear end of the pen in the winter season and also (the slope of the roof is such as) to give shade in that portion in summer.

"2d. The lattice construction between the pens, at the ends and rear, admit of a free circulation of air in warm weather.

"3d. The location of the manure pit in the center and below the

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a. Note. Each pen has been made six inches wider than in the original plans of this piggery in order to allow the opening of any gate independently of the others.

b. Note. Quotation marks refer to Maryland Bulletin No. 63, p. 3.

level of the sleeping and feeding floors with all drainage towards it, aids materially in maintaining a proper sanitary condition." "The manure pit is concreted which enables the saving of all liquid excrements."

4th. "The swinging gates close the pigs into their beds," facilitate the "changing of pigs from pen to pen" and allow the easy removal of manure.

5th. "The swinging fronts to the pens permit the food to be easily placed in the trough and evenly distributed so that the pigs have an equal chance at feeding time."

6th. "A feed bin is placed in front of each pen which facilitates feeding and enables keeping different feed for each pen if desired."

7th. "The general plan can be used and the dimensions and materials modified so as to meet the demands of circumstances."

The question most often asked about this piggery is whether it is warm enough. This can be answered in the affirmative except for very cold winter weather. When a sheltered location can not be chosen, sufficient protection can be furnished by some kind of movable or swinging frames to close the beds during extremely cold nights. Another question often asked is whether the cement floor is conducive to the health and comfort of the pigs. The cement floor is satisfactory in this respect for a large part of the year, and during winter, the feeding floor is the only part not covered heavily with bedding.

Provision is made in the plans of this piggery for outlets at the north ends of pens to yards for exercise. The yard is a valuable accessory to a building of this nature, and, in choosing the site, care should be exercised to allow space for yards.

A PORTABLE HOG COT.

(Modified Lovejoy Type.)

Originality is not claimed by this Station for the general design of this hog cot. The portable hog cot in several styles has been in use for several years by some of the Experiment Stations and some well known hog breeders. The Illinois, Wisconsin and Michigan Experiment Stations, especially, have taken an active part in designing and improving this kind of hoghouse. The chief advantages of the portable hog cot are that it can be moved from place to place, that it is comparatively inexpensive, and that each hog or bunch of hogs can be given a separate shelter. The portability makes possible the isolation of sick hogs, the sheltering of hogs on temporary pasture, and the moving of the cot if the surroundings become insanitary. The size of the hog cot makes it easier to warm from the body heat of the animals, and also reduces the drafts.

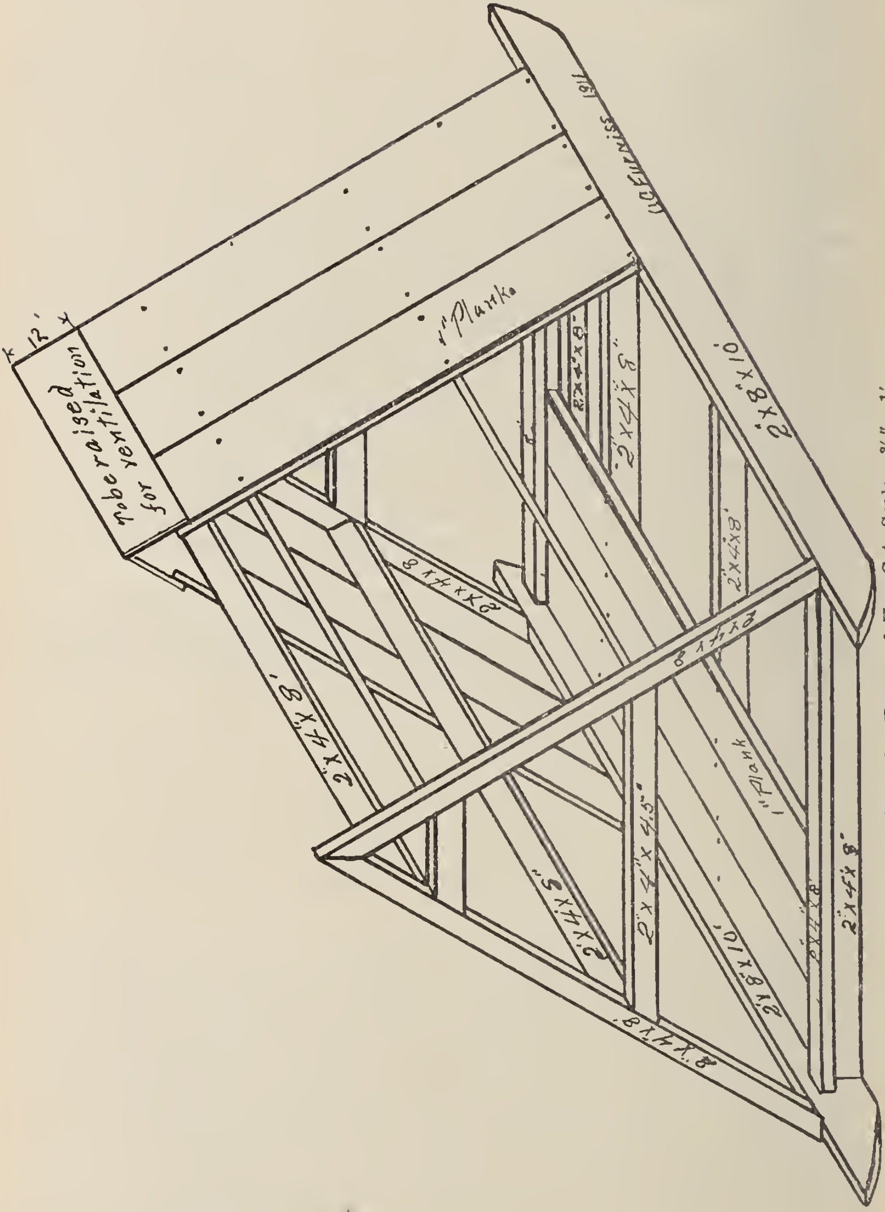

Figure 9.—Frame of Hog Cot. Scale—⅜"=1'.

The cot shown in Fig. 9 has proven satisfactory at this Station. The whole of the frame is made of 2"x4" scantling except the two runners at the sides which are 2"x8". The floor, which is separate from the rest of the cot, is made of inch boards nailed on 2"x4" cross-pieces. The ends and roof of the cot are covered with inch boards. The whole outside of the cot may be covered with roofing paper, in which case rough lumber can be used and the width of the roof boards is not important. But if no roofing paper is used the roof should be made of wide boards and the cracks covered with strips.

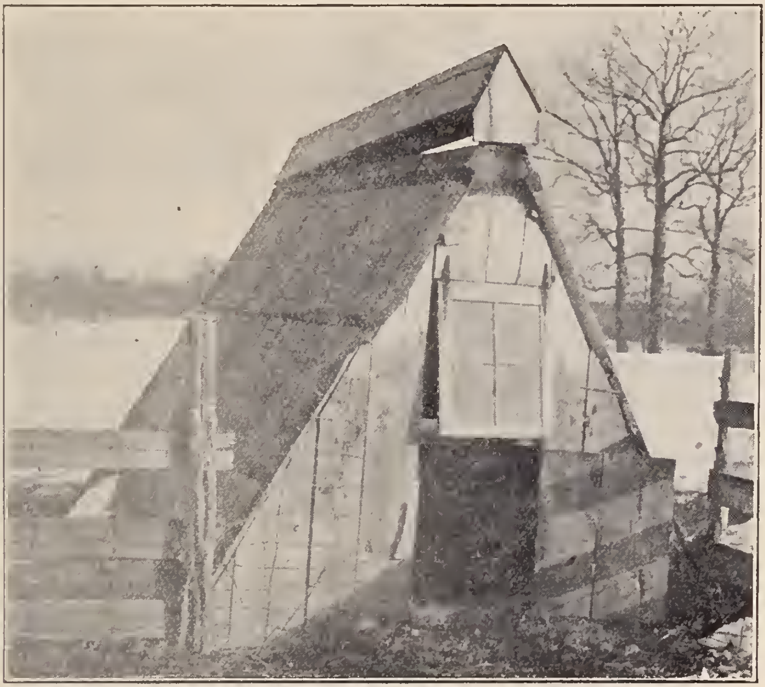

Figure 10.—Portable hog cot showing door, window and ventilator.

In each end of the cot is a door 2'-4" high and 1'-10" wide hinged at the side to open outward. In the south end of the cot is a window sash above the door and of the same size which is hinged at the top to open outward. The door in the north end of cot may be hinged at top if preferred. Fenders to prevent brood sows from overlying pigs at farrowing time may be provided by placing two 1"x10" boards on edge, eight inches from the floor and lengthways of the cot, with about four feet between them. These fender boards should fit into slots at the ends so that they can be removed when not needed. Ventilation is provided by raising the two wide boards placed in the shape of an inverted trough over the comb of the roof.

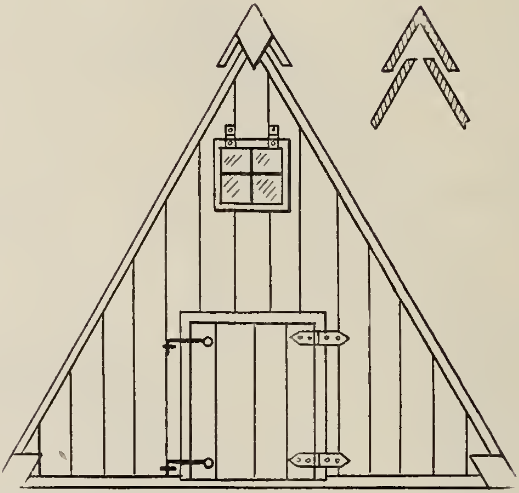

Figure 11.—Lovejoy Portable Hog House, end elevation.
(Copied from U. S. Dept. of Agrl. Farmers' Bulletin No. 205.)

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 151. FEBRUARY, 1911.

FERTILIZERS ON ASPARAGUS.

By C. P. Close, T. H. White and W. R. Ballard.

INTRODUCTION.

Asparagus has become a most popular vegetable and is grown in nearly all portions of the country. Perhaps the largest areas devoted to its culture are within comparatively easy reach of the largest cities, but it is often shipped across the continent from California to New York City. It adapts itself to many types of soils and to being planted in areas of a few hills in gardens to hundreds of acres in field culture.

For a crop so universally grown as asparagus it seems strange that so little has been published of results of experiments with commercial fertilizers and manures. The accounts given in bulletins and reports are in nearly every case too incomplete to be of much value.

OBJECT.

The object of this experiment was to make comparisons and tests as follows:—

1. Commercial fertilizer versus barnyard manure.
2. Different sources of potash.
3. Light and heavy applications of kainit.
4. Heavy applications of nitrate of soda in spring.
5. Heavy applications of salt.
6. Manure in different amounts with and without commercial fertilizer.
7. Different times of applying manures and fertilizers.

THE PLAN.

The Experiment Station Asparagus bed was started in 1903 on medium loam of good fertility, one year old plants being used for planting. In the spring of 1905 the fertilizer experiment was inaugurated.

A portion of bed was divided into twenty plots each $\frac{1}{100}$ of an acre in extent.

The plots were arranged in two tiers of ten each, one in each tier being a check without any fertilizer. Aside from the difference in fertilizing the plots, all received the same care and cultivation.

The various amounts of fertilizing materials used on the different plots are mentioned below. This experiment was planned by Director H. J. Patterson and Prof. W. N. Hutt who was then Horticulturist of the Experiment Station.

Plot 1. Dissolved rock 400 pounds, kainit 400 pounds, nitrate of soda 200 pounds; applied in early spring.

Plot 2. Same as plot 1 but was applied two weeks after the cutting season ended.

Plot 3. Same as plots 1 and 2 but was applied in October.

Plot 4. Dissolved rock 400 pounds and kainit 400 pounds, applied two weeks after the cutting season ended, and 200 pounds nitrate of soda in early spring.

Plot 5. Check.

Plot 6. Nitrate of soda 500 pounds in early spring.

Plot 7. Muriate of potash 120 pounds two weeks after cutting season ended.

Plot 8. Sulphate of potash 120 pounds two weeks after cutting season ended.

Plot 9. Kainit 500 pounds two weeks after cutting season ended.

Plot 10 Kainit 2000 pounds two weeks after cutting season ended.

Plot 11. Dissolved rock 500 pounds two weeks after cutting season ended.

Plot 12 Rotted manure 10 tons two weeks after cutting season ended.

Plot 13. Fresh manure 20 tons in early spring.

Plot 14. Check.

Plot 15. Fresh manure 20 tons two weeks after cutting season ended.

Plot 16. Fresh manure 20 tons in October.

Plot 17. Fresh manure 10 tons and kainit 400 pounds, two weeks after cutting season ended.

Plot 18. Fresh manure 10 tons, dissolved rock 400 pounds and kainit 400 pounds two weeks after cutting season ended.

Plot 19. Fresh manure 10 tons, dissolved rock 400 pounds, kainit 400 pounds and nitrate of soda 200 pounds in early spring.

Plot 20. Salt 2000 pounds two weeks after cutting season ended.

Each plot should have had 44 plants, but in some cases a few plants were missing.

DETAILS OF THE WORK.

During the six seasons of this experiment, from 1905 to 1910 inclusive, the manure and fertilizer were applied broadcast according to the outline above. As soon as the spring applications were made, two furrows were plowed from each side over the rows and a harrow was run crosswise and then lengthwise of the rows to level the ground so as to produce green shoots instead of white ones. Once during the cutting season this same treatment was given, and then again when the fertilizer and manure were applied after the cutting season. In 1909 and 1910 a double disc cultivator ,was used instead of the plow and only one harrowing was necessary to level the ground.

The cutting season of each year was as follows:—

In 1905, from April 28 to May 13; in 1906, from May 1 to June 14; in 1907, from May 1 to June 17; in 1908, from April 24 to June 9; in 1909, from May 5 to June 15; in 1910, from April 6 to June 6. The stalks were cut two or three times a week and those from each plot were counted and weighed.

Table I shows the number of plants in each plot, the number of stalks and the weight of crop of each plot each year, and the total yield of each plot for the six seasons. Table II shows in ounces the total yield of each plot and each plant for six years and the estimated total yield in pounds per acre for each plot for six years on a basis of a full stand of 4400 plants per acre.

The plan on page shows at a glance the kind and amount of fertilizer used and when applied, the cost of manure or fertilizers, the estimated yield per acre for six crops, and the gain or loss for each plot treatment.

In arriving at these figures fresh manure was valued at $2.00 per ton, rotted manure at $3.00 per ton, kainit at $10.00, sulphate of potash at $45.00, muriate of potash at $42.00, nitrate of soda at $45.00, dissolved rock at $12.00 and salt at $8.00 per ton. The price of asparagus is averaged at eight cents per pound for the six years.

TABLE I.

Shows the Number of Plants in Each Plot, the Number of Stalks and the Weight of Crop of Each Plot Each Year, and the Total Number of Stalks and Yield of Each Plot for the Six Seasons.

Plots.	Number of Plants in Plots.	1905.			1906.			1907.			1908.			1909.			1910.			Totals.		
		Yield.			Yield.			Yield.			Yield			Yield.			Yield.			Yield for 6 yrs.		
		No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.	No. Stalks.	Pounds.	Ounces.
1	35	82	3	8	315	19	4	409	21	15	550	31	9	651	34	14	685	32	00	2692	143	2
2	44	93	3	12	266	19	10	278	16	11	425	26	2	427	26	2	420	25	4	1909	117	9
3	43	99	4	8	285	20	2	353	19	8	602	35	4	681	39	11	682	38	9	2702	157	10
4	43	103	4	1	376	25	0	420	21	2	629	35	2	659	35	7	633	35	10	2820	156	6
5	33	76	3	7	245	14	4	283	13	8	411	19	4	460	24	11	464	21	12	1939	96	14
6	35	68	3	1	199	12	1	249	13	5	365	19	0	435	21	10	464	21	3	1780	90	4
7	35	87	3	5	282	17	9	310	16	12	405	22	8	467	23	9	450	22	14	2001	106	9
8	39	93	3	9	268	17	3	332	16	8	500	24	8	564	26	12	557	25	8	2314	114	0
9	26	65	2	8	234	15	2	274	15	4	375	21	2	434	26	11	421	20	10	1803	101	5
10	34	86	2	15	299	18	11	380	20	1	555	31	11	703	38	6	660	32	10	2683	144	6
11	41	119	4	10	339	18	11	415	18	8	518	25	12	608	28	0	579	31	11	2578	127	4
12	35	69	2	11	215	13	7	300	16	1	558	26	2	445	27	10	519	29	14	2106	115	13
13	37	74	3	6	221	12	10	404	23	3	591	42	9	676	42	0	746	43	0	2712	166	12
14	37	114	4	9	308	18	4	398	18	14	610	29	2	650	32	8	618	31	0	2698	134	5
15	39	101	3	11	291	16	7	381	18	10	484	26	7	512	32	5	585	35	2	2354	132	12
16	39	90	3	6	294	16	14	400	20	14	562	32	14	655	35	9	676	36	11	2677	146	4
17	37	72	2	13	306	18	8	342	16	14	478	26	6	611	28	8	569	29	0	2378	122	1
18	34	91	3	2	290	17	11	393	20	1	539	27	3	544	31	8	595	33	3	2452	131	12
19	39	89	3	6	360	22	10	436	22	9	612	37	7	640	40	5	700	42	1	2837	168	6
20	36	117	3	14	358	20	1	405	19	15	594	31	5	612	34	12	604	28	10	2690	138	9

TABLE II.

Shows Total Yield in Ounces for Each Plot for Six Years, Average Yield per Plant in Ounces and Yield per Acre for Full Stand of 4,400 Plants for Six Years.

No. of Plot.	Total Ounces.	Ounces. per plant.	lbs. per acre for 4400 plants
1	2290—	—65.4—	—17991
2	1881—	—43.1—	—11756
3	2522—	—58.6—	—16126
4	2502—	—58.2—	—15998
5	1550—	—47.2—	—12914
6	1444—	—41.2—	—11343
7	1656—	—47.3—	—13393
8	1824—	—46.7—	—12861
9	1621—	—62.3—	—17142
10	2310—	—68.0—	—18682
11	2036—	—49.6—	—13653
12	1853—	—53.0—	—14559
13	2670—	—72.2—	—19826
14	2149—	—58.0—	—15972
15	2122—	—54.4—	—14973
16	2340—	—60.0—	—16500
17	1953—	—52.7—	—14515
18	2108—	—62.0—	—17050
19	2693—	—69.0—	—18994
20	2217—	—61.5—	—16935

Plan and Results

Total Amounts and Cost of Fertilizer and Manure, Yield of Crop and Gain or Loss are per Acre for a Period of Six Years

Plot 1 2400# Dis. Rock 2400# Kainit 1200# Nit Soda In Early Spring Cost $53.40 Yield 17991# Gain $352.76	Plot 2 2400# Dis. Rock 2400# Kainit 1200# Nit. Soda In Midseason Cost $53.40 Yield 11756# Loss $146.04	Plot 3 2400# Dis. Rock 2400# Kainit 1200# Nit. Soda In October Cost $53.40 Yield 16126# Gain $203.56	Plot 4 2400# Dis. Rock 2400# Kainit In Midseason 1200# Nit. Soda In Early Spring Cost $53.40 Yield 15998# Gain $193.32	Plot 5 Check Yield 12914#	Plot 6 3000# Nit Soda In Early Spring Cost $67.50 Yield 11343# Loss $193.18	Plot 7 720# Mur. Potash In Midseason Cost $15.12 Yield 13393# Gain $23.20	Plot 8 720# Sul. Potash In Midseason Cost $16.20 Yield 12861# Loss $20.44	Plot 9 3000# Kainit In Midseason Cost $15.00 Yield 17142# Gain $323.24	Plot 10 12000# Kainit In Midseason Cost $60.00 Yield 18682# Gain $401.44
Plot 11 3000# Dis. Rock In Midseason Cost $18.00 Yield 13653# Loss $203.52	Plot 12 60 Tons Rotted Manure In Midseason Cost $180.00 Yield 14559# Loss $293.04	Plot 13 120 Tons Fresh Manure In Early Spring Cost $240.00 Yield 19826# Gain $68.32	Plot 14 Check Yield 15972#	Plot 15 120 Tons Fresh Manure In Midseason Cost $240.00 Yield 14973# Loss $319.92	Plot 16 120 Tons Fresh Manure In October Cost $240.00 Yield 16500# Loss $197.76	Plot 17 60 Tons Fresh Manure 2400# Kainit In Midseason Cost $132.00 Yield 14515# Loss $248.56	Plot 18 60 Tons Fresh Manure 2400# Dis. Rock 2400# Kainit In Midseason Cost $146.40 Yield 17050# Loss $60.16	Plot 19 60 Tons Fresh Manure 2400# Dis. Rock 2400# Kainit 1200# Nit. Soda In Early Spring Cost $173.40 Yield 18994# Gain $68.36	Plot 20 12000# Salt In Midseason Cost $48.00 Yield 16935# Gain $29.04

DISCUSSION OF RESULTS.

The plan on page 140, shows at a glance the time of applying the manure and fertilizer and results of the six years work. The amounts of fertilizer and manure per acre mentioned were applied each year, but the value of the fertilizer and manure and the total yield per acre are for the entire period of six years.

In all cases of gains in yield over check plots the value of the fertilizers or manure used is deducted from the value of the increased yield so as to give net gains. Where the yields fall below that of the checks the cost of fertilizers and manures is added to the loss to give the total loss for each plot.

The first comparison includes plots 1, 2, 3, 4 and the check 5. On plots 1, 2, 3, and 4 the same amounts of fertilizer were used, but the time of application was different and the yields seem to indicate that early spring is the best time for using commercial fertilizer on asparagus beds. Comparing plot 1 where fertilizer was applied in early spring and plot 2 where it was applied two weeks after the cutting season, the early application resulted in a profit of $352.76 and the late application in a loss of $146.04 compared with the check plot, a difference of $498.80 per acre in favor of plot 1 over plot 2 for a period of six years. The use of fertilizer on plot 3 in October, and of dissolved rock and kainit two weeks after the cutting season and nitrate of soda in early spring on plot 4, gave nearly the same results, being a gain of $203.56 for plot 3 and a gain of $193.32 for plot 4 for six years. The result on plot 4 is inconsistent compared with plots 2 and 6 where fertilizer applied two weeks after the cutting season and nitrate of soda in the spring apparently caused even smaller yields than that of the check plot.

On plot 6 the use of 500 pounds of nitrate of soda in early spring resulted in a loss of $193.18 in six years.

One hundred and twenty pounds of muriate of potash applied two weeks after the cutting season on plot 7 gave a gain of $23.20 and the same amount of sulphate of potash used at the same time on plot 8 caused a loss of $20.44 per acre in six years.

Kainit has long been supposed to be a good fertilizer for asparagus and the results on plots 9 and 10 bear out this supposition. Unfortunately, it was used after the cutting season only so no results from early spring applications are available for comparison. On plot 9 where it was used at the rate of 500 pounds per acre the gain was $323.24 and on plot 10 where one ton per acre was used the gain was $401.44. The cost of kainit on plot 10 was $45.00 more than on plot 9 and the increased value of the crop on plot 10 over plot 9 was $78.20 so the use of the larger amount was the more profitable. In other words the investment of $45.00 brought returns of $78.20.

The check for plots 11 to 20 inclusive produced a much heavier crop than did the check for plots 1 to 10 inclusive and there is no apparent reason for this. If check plot 5 were used for comparison with plots

11 to 20 inclusive they would show up much better than they do by comparison with check plot 14.

Plot 11 with 500 pounds of dissolved rock per acre two weeks after the cutting season shows a loss of $203.52.

Plot 12 with 10 tons of rotted manure applied two weeks after the cutting season shows a loss of $293.04.

Comparing 20 tons of fresh manure applied in early spring on plot 13 with the same amount two weeks after the cutting season on plot 15 and in October on plot 16, we have a gain of $68.32 for the spring application, a gain of $197.76 for the October application and a loss of $319.92 for the mid-summer application. Plot 13 gave the heaviest yield of any plot in the experiment, but the gain was low because of the high cost of the manure.

Plot 17 was given ten tons of fresh manure and 400 pounds of kainit two weeks after the cutting season and plot 18 was similarly treated and also had 400 pounds of dissolved rock additional. The former shows a loss of $248.56 and the latter a loss of $60.16. Although the yield of plot 18 was much heavier than the check plot the increase was not enough to pay for the fertilizer and manure used.

Plot 19 received a liberal dressing of manure and fertilizer in early spring and although the yield was heavy the expense of the manure and fertilizer cut down the gain to $68.36. The amounts used were 10 tons fresh manure, 400 pounds dissolved rock, 400 pounds kainit and 200 pounds of nitrate of soda. This plot might reasonably be expected to give the highest yield of any, but it is exceeded by plot 13 where 20 tons of fresh manure were used in early spring.

Salt at the rate of 2000 pounds per acre was used on plot 20, two weeks after the cutting season and gave a gain of $29.04 for six years. The salt seemed to have no effect on keeping down weeds.

SUMMARY OF EXPERIMENT.

Kainit at the rate of 2000 pounds per acre applied in mid-summer gave the highest net gain per acre of any of the plots.

Dissolved rock 400 pounds, kainit 400 pounds and nitrate of soda 200 pounds per acre applied in early spring gave the next best net returns.

Kainit at the rate of 500 pounds per acre in mid-summer gave the third best net returns.

Muriate of potash gave better results than sulphate of potash.

Nitrate of soda alone in early spring reduced the yield.

Dissolved rock alone in mid-summer was not beneficial.

Salt seemed to increase the yield slightly.

Manure is too expensive to apply year after year. In seven manure plots only two produced any profit.

Dissolved rock 400 pounds, kainit 400 pounds, and nitrate of soda 200 pounds per acre used in early spring gave a profit of $352.76 while the same fertilizer plus 10 tons of fresh manure in early spring yielded more asparagus but the profit was only $68.36, the high cost of manure making the difference in profit.

Manure and fertilizer combinations are desirable in moderate amounts, but are too expensive in the heavy applications made in this experiment.

The best time to apply manure or fertilizer is not settled by these tests, but leaving out the two kainit plots (9 and 10) the early spring applications were followed by the heaviest yields.

CULTURE OF ASPARAGUS.

Origin: The Asparagus (*Asparagus officinalis*, Linn.) is native to Europe and Asia and has been in cultivation for two thousand years.

Propagation. It is grown from seed which is sown about one and one-half inches deep in rows from one to three feet apart in a well prepared seed bed. One ounce of seed will plant fifty feet of row and produce from 200 to 400 plants. Since the seed is slow in starting, it is well to scatter in some radish seed so that the rows will be outlined and the ground can be cultivated to keep down the weeds. An abundance of humus is necessary in the soil and good care is essential to make strong one year old plants for setting in the field. If necessary the plants must be thinned to three inches apart in the row. A rich sandy loam makes the best seed bed.

While young, it is practically impossible to distinguish the male plants from the female ones, unless they are in bloom. The male plants are more vigorous and productive than the female plants which produce the berries.

In saving seed, take berries from strong plants producing only a few berries. When these are scarlet-red and fully ripened cut the shoots and hang up to dry. Soak the berries in water about two days and loosen the seed from its covering by rubbing with the hands. Spread out the seed to dry and then store in paper or cloth bags. After two years the seed does not germinate well.

Soil and Fertilizers for Field Culture. Almost any well drained soil with plenty of humus in it will grow asparagus, but a good rich sandy loam is best. In preparing the ground for planting it should be deeply plowed and have large quantities of rotted manure worked into it. The asparagus grower must use whatever commercial fertilizer he has most faith in because experimenters and growers do not agree as to what is best. Perhaps 1000 to 2000 pounds of kainit per acre in midseason is as good as anything, however, if a complete fertilizer is preferred the following is good:—400 pounds dissolved rock, 400 pounds kainit and 200 pounds nitrate of soda in early spring.

Plants. The very best plants are strong one year olds. About the only advantage in using older plants is to wait until they bloom so as to distinguish the males from the females and select the males which are the strongest and best producers.

Planting: After being thoroughly worked up the ground should be laid off in furrows six to eight inches deep and from four to six feet apart. The best time for planting is early in the spring. The plants are set about two feet apart in the furrows and where they are placed the ground is often mounded slightly. The roots are spread out carefully and the earth is filled in two or three inches over the plants or "crowns" and as growth proceeds the ground is cultivated in until the furrows are finally filled. Thorough cultivation should be continued during the entire season and in late fall the tops should be cut off and removed from the field and be burned to destroy disease germs and insects.

SECOND YEAR.

A good coating of stable manure, or one thousand pounds of kainit per acre, or both, should be applied early in the spring and the entire surface should be plowed four inches deep. After thorough harrowing the shoots may be given time to grow a few inches when cultivation should be begun and be repeated every ten days or two weeks during the season. In late fall the stalks are again cut off and removed for burning. No cutting for market should be done the second year.

THIRD AND SUCCEEDING YEARS.

A light covering of rotted manure, about five tons per acre, should be given during the winter or early spring every year if possible, or every second year certainly. In connection with this manure some commercial fertilizer should be used, either a complete fertilizer as mentioned below or kainit 1000 to 2000 pounds per acre. If manure is not available then a complete fertilizer must be used in early spring, at least 400 pounds dissolved rock, 400 pounds kainit and 200 pounds nitrate of soda.

The ground should be plowed and harrowed again in early spring.

The kind of stalks desired for cutting, whether green or white, will determine how the ground will be handled at this time. If "green" stalks are wanted the ground may be left nearly level or at most only a slight ridge be made over the row.

If "white" stalks are desired, furrows from each side must be thrown over the row to form a round or flat topped ridge eight or more inches high. There are special asparagus plows which do this ridging to perfection. The stalks must grow through the ridge and are blanched by doing so. The ground must be kept cultivated to keep down weeds.

As soon as the cultivating season is over in June, the entire ground is plowed about four inches deep and well harrowed. The shoots are then allowed to grow. Good cultivation must be given so that large amounts of plant food may be stored up in the roots and crowns to produce strong shoots the following year. After the tops die in the fall they should be removed and burned as before.

This treatment is given year after year as long as the plants are profitable.

The use of salt is not injurious to asparagus, but it is not necessary.

Asparagus may be forced in a cellar or greenhouse by digging the roots late in fall and storing in earth in a pit or cellar. When ready to force they must be placed where it is warm and be watered as required.

Cutting and Marketing the Crop. Green stalks are gathered when the shoots are six or eight inches high and they are cut an inch or two below the surface.

The white stalks are taken when the tips are an inch or two above the ridge and must be cut off with a special asparagus knife six or eight inches below the surface.

The shoots are tied in bunches about three inches in diameter. Bunching boxes are used so the head ends may be placed even and the butt ends are cut off at the open end of the box so all bunches will be of the same length. The bunches are tied with raffia, soft cord or rubber bands and all packed in crates for shipment. See following cuts from Bulletin 116.

*INSECTS AND DISEASE.

Asparagus Beetle, (*Crioceris asparagi*) and Twelve Spotted Asparagus Beetle, (*Criocercis duodecimpunctata*). The beetles appear in early spring. Keep all shoots cut off and after the cutting season ends spray with arsenate of lead two or three pounds in 50 gallons of water or bordeaux, using resin soap to make the mixture stick to the foliage. Spray every two weeks if necessary. Apply air slaked lime when young first appear and during a hot day jar the plants to make the young drop to the ground where they perish.

Rust (*Puccinia asparagi*), The rust causes the foliage and stems to turn brownish and mature early. Spray with bordeaux and resin soap every two or three weeks after the middle of July. Cut off and burn dead tops in late fall. Good cultivation, or humus in the soil, to retain moisture, will help retard the serious injury of the disease.

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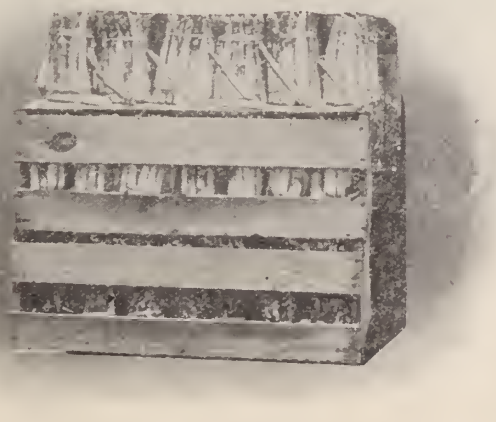
*See bulletins 115 and 143.



Asparagus Packed for Shipment, with Specimen Bunches on Top

Asparagus Bunched for Market.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 152. APRIL 1911.

APHIDIINAE OF NORTH AMERICA.*

By A. B. Gahan.

INTRODUCTION.

In taking up the study of the hymenopterous family *Braconidae* in 1907 the writer was at once impressed with the great difficulty experienced in the identification of species of the important sub-family *Aphidiinae*. Owing to inadequate and in some cases faulty descriptions of species, confusion of genera in many instances, and the general failure of writers to recognize or allow for variations, it was found almost impossible to identify specimens with any degree of certainty. The evident need for a better understanding of this interesting group led the writer to confine his study for the most part to an attempt to straighten out its classification and learn more about the habits and host relations of the different species. The results of this study as here set forth are not as complete as could be desired owing to the impossibility of securing certain types, but it will, it is believed, aid in a better understanding of the group.

In the course of the preparation of this treatise a careful comparison and study of all the types of Ashmead and Fitch in the United States National Museum as well as of all the available types, of Provancher, Cresson, Cook, Rohwer, Garman, Viereck and Withington have been made. The study of the types has been supplemented wherever possible by study of cotype and homotype material, as well as of large series of reared specimens of various species and some breeding work from known parents. The genera and species placed in synonymy have been so treated only after careful consideration and in the light of the knowledge gained of the range of variation from the study of extensive series of reared specimens from numerous hosts.

Five new species are described and in order to point out new characters, correct errors in former descriptions, obviate the confusion in certain cases resulting from the numerous descriptions of the same species under different names, as well as to bring the descriptions all together in a convenient form for reference a redescription is included of all the established species of which authentic specimens could be obtained. In the case of those species of which types or authentic specimens were not available but which could be recognized by characters given in the original description, the original description is reproduced. Eight species, the identities of which are considered doubtful, are listed.

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* The study of these important parasites was undertaken as an Adams' Fund project. As is shown in the following pages this group of parasites has been greatly confused by workers in Entomology. It was found necessary to revise the classification of the group preliminary to a satisfactory study of individual species in their economic relations.

It is hoped that this comprehensive study and classification of the subfamily will lead to a better understanding of these parasites and will facilitate further study of their economic relations as natural aids in the control of many of our common insect pests.—Thomas B. Symons.

All figures are from drawings by the writer and will serve to illustrate some of the characters used in the classification. A Zeiss binocular microscope has been used in the study and comparison of specimens.

The writer is indebted to Professor R. H. Pettit, of the Michigan Agricultural College, Rev. V. A. Huard, of the Museum of Public Instruction of Quebec, Professor S. J. Hunter, of Kansas University, and Mr. C. A. Hart, of the Illinois Laboratory of Natural History, for the loan of types; to Professor G. A. Dean, of the Kansas Agricultural College and Professor C. P. Gillette of the Colorado Experiment Station, for contribution of specimens for study; to Dr. Henry Skinner and E. T. Cresson, Jr., of the Philadelphia Academy of Sciences for courtesies in connection with a visit to that institution; and especially to Messrs. J. C. Crawford and Henry L. Viereck of the United States National Museum for assistance and numerous courtesies in connection with the study of the types in that museum. To all of these gentlemen I wish to express my hearty appreciation.

Finally I wish to acknowledge my indebtedness for the encouragement, cooperation and many useful suggestions extended by Prof. Thos. B. Symons who has had general supervision of the work.

ICHNEUMONOIDAE (Superfamily)

Braconidae. (Family)

Aphidiinae. (Subfamily.)

1838. *Aphidiidae* Haliday, Family V., Ent. Mag., V., p. 212.
1840. *Flexiliventres* Westwood. Div. VI., Intro. Mod. Class. Ins. II., Synop. p. 65.
1862. *Aphidiodae* Foerster, Family XIV., Verh. naturh. Ver. preuss. Rheinl., XIX, p. 228.
1880. *Flexiliventres* Provancher, Div. VI., Natur. Canad., p. 136.
1885. *Aphidiides* Marshall, Trans. Ent [illegible]
1887. *Aphidiinae* Cresson, Subfamily, Synop. Hymen. N. A., p. 56.
1888. *Aphidiidae* Marshall, Tribe XXV, Spec. d. Hym. d. Eur., IV., p. 67.
1900. *Aphidiinae* Ashmead, Subfamily I, Smith's Ins. N. J., p. 586.
1901. *Aphidiinae* Ashmead, Subfamily I, Proc. U. S. Nat'l Museum, p. 111.
1904. *Aphidinae* Szepligeti, Subfamily XXVIII, Gen. Insect., Fascicule 22, p. 6.

This group of parasites has been variously treated by different hymenopterologists, some of the earlier writers considering it a distinct family but the modern view places it as indicated above as a subfamily of the *Braconidae*. Although differing considerably structurally from the typical *Braconidae* the resemblance in most of the details is sufficient to establish its relationship. The fact that all the segments of the abdomen are freely flexible separates the group from all others of the family while the wing venation is for the most part somewhat more simple and attenuated than that of other *Braconidae*.

The group is admittedly one of the most difficult to classify since there are very few good characters to distinguish either genera or species. Owing to misunderstanding of the range of variation a number of unnecessary and it is believed untenable genera have been erected, and for the same reason, combined in some cases with misunderstanding of habits, numerous duplicate descriptions of species have been published. The genera have in large part been founded upon differences in wing venation and so fine have these distinctions been drawn in some instances that much confusion has resulted. Marshall recognized none of Foerster's genera while Ashmead and Szepligeti as well as some others have attempted to recognize all of the Foersterian genera although several are founded upon such minute variations in the wing venation and sculpture of the propodium as to be very confusing. It has been the intent of the writer to retain all genera which seemed to be sufficiently distinct to be recognizable and to suppress only those which for good reason are unnecessary and conflicting.

American writers with the exception of Provancher and Ashmead have confined themselves almost entirely to descriptions of species. Provancher evidently had a very hazy and imperfect understanding of the group as all of the seven genera erected by him have been either transferred to other groups or suppressed as synonyms of genera previously described. Dr. Ashmead while familiar with most of the genera was yet confused in one or two instances and wrongly placed several of his species. Owing to his failure to allow for any variation in the number of antennal joints or color and his evident belief that each species was confined in its parasitism to a single host he originated several specific names which are undoubtedly synonyms. Fitch's species are mostly good but generally wrongly placed generically. Cresson, Cook, Garman, Viereck, Withington and Rohwer have each published descriptions of a small number of species, some of which are good and others synonyms. Mr. C. F. Baker in 1909 published a paper in which he described nine new species of Aphidiinæ.[1] The types of these I have unfortunately been unable to obtain and the descriptions of some are too inadequate to enable them to be definitely separated from others previously described. Those whose descriptions afford available characters for distinguishing them have been included in the tables of species.

HABITS AND LIFE HISTORY.

The habits of this group of parasites are among the most interesting of all the parasitic Hymenoptera. Various writers have ascribed to different species hosts other than plant lice (*Aphididae*) but it is extremely doubtful whether any species really does parasitize insects of other families. Instances are recorded in literature of parasitism by *Aphidiinae* of *Coleoptera, Lepidoptera, Diptera* and *Hymenoptera*. Dalle Torre in his "Catalogus Hymenopterorum" apparently credits Marshall with having recorded rearings of these insects from *Hymenoptera* but as a matter of fact Marshall's records are of the rearing of hymenopterous hyperparasites from *Aphidiinae*. The references to rearings from *Diptera* are quite numerous, some species of *Cecidomyid* usually being mentioned as the victim. The galls of these flies occur on the leaves and stems of plants which are very apt to be infested with plant lice and in some instances their galls are not easily distinguished from those made by aphids. The chances for error in such cases are apparent. In collecting material for rearing of other insects such as

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[1] Pom. Jour. Ent., Vol. I, p. 22.

Coleoptera, Lepidoptera and *Diptera* it is a very easy matter for a few parasitized aphids to be overlooked and thus furnish the basis for a wrong conclusion as to the source of a parasite. There seems to be no record of any actual observation of one of these parasites ovipositing in or issuing from an insect other than an aphid and until such observations are forthcoming and in view of the known habits of the great majority of the species it is safe to consider all records of other insects as hosts as erroneous.

The method of ovipositing is alike for the whole group so far as is known. The parasite approaches the proposed host (usually a half grown wingless female aphid, although the winged females are not infrequently parasitized also) from the side or rear, taps it gently with the antennae, apparently for the purpose of ascertaining whether it has been previously parasitized or not and if found satisfactory the abdomen of the parasite is quickly bent beneath the thorax, the apex extended beyond the head and by a quick thrust the ovipositor is driven into the abdomen of the host and an egg deposited there. The rather long legs of the parasite permit the elevation of the body so that this movement can be executed, besides furnishing ample braces to steady the body and withstand the thrust.

The larva feeds within the abdomen of the aphid assuming a curled or looped position as it develops and when fully developed, completely fills the abdominal cavity. The host continues to feed until the larva is fully grown. The power of reproduction of the host is stopped, however, soon after the parasitic larva begins feeding and this fact is an imprtant factor in the control exercised by the parasites over the increase of any species of aphid. Professor F. M. Webster has observed this to be true in the case of the parasite of *Toxoptera graminum*[2] and observation of numerous other species leads me to believe it the rule.

When full grown the larvae of most of the species cut a slit in the ventral surface of the abdomen of the now dead host, fasten it to the leaf and seal the slit with a film of silk and then pupate within the aphid's body using its body walls in lieu of a cocoon. At this stage the parastized aphids are easily recognized being greatly swollen, smooth, hard, and shining. When ready to emerge the parasite cuts a small circular piece out of the wall of the aphid's abdomen often leaving this piece with a slight hinge so that it drops back into place like a trap-door when the insect has crawled out. Species of the genus *Praon* modifv this process to some extent. Instead of pupating within the aphid's body the *Praon* larva crawls out through the slit in the ventral surface and proceeds to spin thin walls of silk between the aphid and the leaf thus forming an enclosed cavity with the aphid's body on top and serving as the roof. Within this cavity or cocoon the larva pupates.

That at least one species of *Aphidiinae* has the power of reproducing parthenogenetically has been proven.[3] There is evidence that the same power is possessed by certain other species and it is probable that all may reproduce in that manner under certain circumstances.

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[2] U. S. Dept. Agri., Bu. Ent., Circ. Bul. 93, p. 14.
[3] Proc. Ent. Soc. Wash., X, p. 13.

One fertile source of confusion in the classification of these insects has been the assumption on the part of authors that each species is confined in its operations to a certain species of aphid as a host. This is an erroneous view. Carefully conducted experiments by various entomologists have shown that it is possible for certain species to reproduce in several different hosts. While it is no doubt true that most species have what may be called a preferred host, I am convinced from the study of rearing records in connection with type and homatype material as well as from many observations in the field and laboratory that many species are by no means limited to a single host but will breed freely in a number of different species of aphids.

Nearly every species of aphid is attacked to a greater or less extent by parasites of this group. So much has been written of the importance of the control exercised by *Lysiphlebus* over the ravages of *Toxoptera* that it is familiar to every one. Not much less important if less well known is the control of *Aphidius nigripes* over another grain aphis, *Macrosiphum granaria. Diaeretus rapae* undoubtedly saves thousands of dollars to cabbage growers each season by its destruction of *Aphis brassicae.* Other species of *Aphidiinae* play an important if not stellar role in keeping down the numbers of the apple aphis, grape aphis, cherry aphis, cotton aphis, and currant aphis, as well as many others which each season attack cultivated plants. It is due to the efficiency of these parasites combined with the efforts of lady-beetles and syrphus-flies that aphids do not every year overrun many of our farm crops and in many cases the chief credit is due to the *Aphidiinae.* It is doubtful whether any other group of parasites of similar extent is responsible for a greater saving to agriculture than is this one.

DESCRIPTION OF THE SUBFAMILY.

The *Aphidiinae* are uniformly minute, slender-bodied insects the largest species measuring not more than four or five millimeters in length. The head is either transverse or quadrate as seen from above and distinctly margined posteriorly, i. e., with a sharp carina separating the occiput from the cheeks, temples and vertex; the temples are convex and usually narrow; the mandibles are triangular, somewhat curved, and bidentate at the apex; maxillary palpi often nearly as long as the head and 2-4-jointed, labial palpi 1-to 3-jointed and short. The antennæe are filiform, many-jointed, the scape and pedicel short and subglobose. Prothorax short. Mesonotum gibbous, the parapsidal furrows present or absent, the mesoscutellum convex not large, mesepisternum large and occupying most of the side of the thorax. Metathorax very short; propodium short, usually convex though sometimes nearly flat or slightly excavated posteriorly, generally areolated but without areolation in the genus *Praon* and with the dividing carinæ often indistinct or absent in some species of the other genera. Legs rather long and slender as in other *Braconidae.* The venation of the forewing is best understood from a reference to the figures. The Stigma is triangular or subtriangular, there are always two complete basal or median cells and the second discoidal cell is usually though not always complete. The rest of the neuration varies greatly. The radial cell is rarely complete and may be entirely effaced. There may be three, two, one, or no cubital cells; when three cubitals occur (*Ephedrus* and *Toxares*) the first discoidal and first cubital are separated and the cubital crossveins and recurrent nervures are present. When but two cubitals are represented the first cubital and first discoidal are confluent and the recurrent nervure complete (*Aphidius* and *Monoctonus*), or the recurrent nervure is absent or incomplete (*Lysiphlebus*): if only one cubital cell is present the cubital crossveins are absent and the first abscissa of cubitus is present with the recurrent nervure either present or absent (*Praon*), or the first abscissa of cubitus is effaced and the recurrent nervure is present (*Dyscritus*): in case of no cubital cells, cubitus, the cubital crossveins and the recurrent nervure are entirely effaced (*Trioxys, Diaeretus*, and *Paralipsis*). The subdiscoidal nervure is usually interstitial though occasionally arising from the middle of the second discoidal cell and is never very distinct. The female abdomen is petiolate or subpetiolate, usually long and lanceolate but occasionally short and ovate (when lanceolate the apex is compressed laterally), the dorsal sutures are all flexible allowing it to be freely bent beneath the thorax; the ovipositor is rarely exserted. The male abdomen is usually short and ovate or spatulate.

Much stress has been laid by various writers upon the supposed constancy in the number of antennal joints for any given species of Aphidiinae. Several writers have made use of this character as a means of separating species. As a matter of fact there is a considerable range of variation in the number of antennal joints of any species falling in the genera *Aphidius, Lysiphlebus, Praon,* and *Diaeretus* (and doubtless also in *Toxares*). This variation has been proven in the case of *Lysiphlebus* by Professor S. J. Hunter in his bulletin. "The Green Bug and Its Parasites"[4] and by Mr. D. W. Coquillet.[5] The writer in a previous paper proved the existence of a like variation in *Diaeretus* and I there mentioned that in the genera *Lysiphlebus, Aphidius* and *Diaeretus* we could expect to find variation to the extent of two joints and usually three joints for each sex in any species.[6] Further observation allows me to include *Praon* also. Although no series of spemimens of *Toxares* or *Monoctonus* have been examined the same statement will probably hold good of those genera. The extent of this variation seems to increase directly as the number of joints in the antennae increase. In species of *Ephedrus* and *Trioxys* which have relatively few joints the number seems to remain constant. In the species of *Lysiphlebus, Aphidius, Praon,* and *Diaeretus* having the least number of antennal joints there is rarely found a variation of more than two joints for each sex while in the species of these genera having the greatest number of joints it is not uncommon to find a range of variation of from three to five joints for each sex. It will readily be seen that any table of species based on the number of antennal joints therefore must prove confusing.

The color also varies markedly in any large series of specimens. The colors common to the group are various shades of black, brown, or yellow and it is a common occurrence to find specimens in which the prevailing colors are more or less diluted so that the fine distinctions which some writers have drawn between the different shades of brown, black or yellow in describing species amount to but very little, unless founded upon examinations of a considerable number of specimens.

On the other hand, the sculpture and areolation of the propodium, the punctuation of the mesonotum, and the shape of the head and clypeus, in some genera afford very good characters for the separation of species. In other genera one is compelled to rely almost wholly upon color. It was hoped that a study of the genitalia might afford useful characters. Mounts were made from both males and females representing several species but with only negative results. It is possible that examination of a greater range of species might reveal useful characters, but in the absence of other than type specimens in many cases, an extensive study was impossible. The accompanying figures, 1 and 2 represent the genitalia of a male and female *Aphidius*.

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[4] Bull. Univ. Kans., Vol. 9, No. 2, p. 159.
[5] Ins. Life, III, p. 313.
[6] Proc. Ent. Soc. Wash., Vol. XII, p. 179.

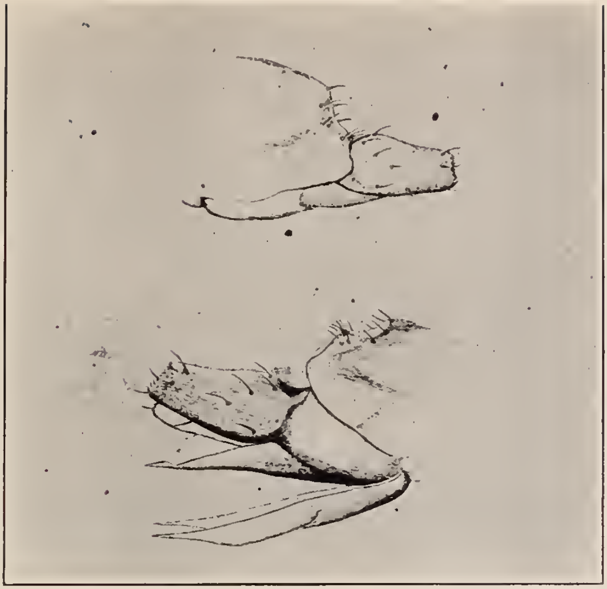

Fig. 1.—Terminal abdominal segment of *Aphidius ribis* Hal., showing the ovipositor sheath closed (upper figure) and open (lower figure). Greatly enlarged.

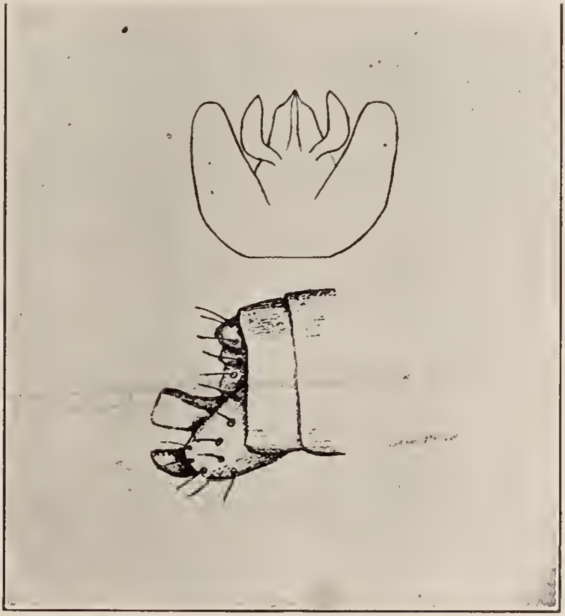

Fig. 2.—Male genitalia of *Aphidius ribis* Hal. Diagram of as viewed from the ventral side. (Upper figure). Lateral view in natural position. (Lower figure). Greatly enlarged.

THE GENERA.

Twenty-five generic names have been used in this group. *Aphidius* was described by Nees von Esenbeck in 1818. In 1833 Haliday characterized *Monoctonus, Ephedrus, Praon, Trionyx,* and *Trioxys*. Wesmæl added *Elassus* in 1835. In 1840 the name *Toxares* was proposed by Haliday. Foerster in 1862 published a table of genera of the *Aphidiinae* in which he included six new genera, viz: *Lysiphlebus, Diaeretus, Paralipsis, Coelonotus, Lipolexis, Adialytus* and *Aclitus*. He at the same time fixed the types for all of his own as well as some of the previously described genera. *Theracmion* was described by Holmgren in 1872 without indicating to what group of Braconidæ it belonged. In 1881 Provancher described *Arotropus* and *Copelus* as new Genera in this group, and followed these in 1886 with descriptions of *Aphidaria, Neuropenes, Ropronia, Radiolaria* and *Scotioneurus*.. Rondani, an Italian writer, introduced the name *Misaphidius* in 1874. Thompson in 1895 accidentally introduced *Coelonotus,* and a year later appeared Marshall's description of *Dyscritus*. The last of the twenty-five, *Protaphidius,* was proposed by Ashmead in 1900 as a substitute for *Coelonotus* which he stated is preoccupied.

Haliday's names were all proposed as sub-genera of *Aphidius,* but with the exception of *Trionyx* all are now recognized and accepted as generic names. *Trionyx* was found to be preoccupied in Reptilia and the name *Toxares* substituted for it. Wesmael's description of *Elassus* is plainly that of an *Ephedrus* and the name has been recognized as a synonym by most writers since 1840. Holmgren's genus *Theracmion* which is catalogued as an Ichneumonid by Dalle Torre[7] is a synonym of *Aphidius* according to A. Roman who has examined the types.[8]

Regarding Foerster's genera there has been much difference of opinion. In the opinion of the writer *Lysiphlebus, Diaeretus* and *Paralipsis* are entitled to rank as good genera. The sole character given by Foerster to distinguish *Coelonotus* from *Aphidius* is that the propodium (metanotum) is hollowed out. Among the species possessing the typical wing venation as well as all the other characters of *Aphidius* is found considerable variation in the shape of the propodium, some species having it quite convex, others nearly flat, while in still others it is sunken or concave. In view of this fact it seems best to accept Marshall's treatment of *Coelonotus* as a synonym of *Aphidius*. *Lipolexis* and *Adialytus* are founded upon characters of minor importance and which are subject to considerable variation making it impossible to separate them from *Diaeretus*. The presence or absence of a second discoidal cell (the hintere mittlere Schulterzelle of Foerster) cannot be accepted as a means of distinguishing genera since in species of *Diaeretus* one will find specimens in which this cell is plainly present while in other specimens it is apparently effaced. The same is true of the crossvein closing the submedian cell (the vordere mittlere

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[7] Cat. Hymenop., Vol. III, p. 1057.

[8] Ent. Tidsk., 1910, Arg. 31, p. 111.

Schulterzelle of Foerster). In at least one species of *Diaeretus* the areolation of the propodium varies all the way from pronounced to practically none at all or so faint as to be barely discernable, so that it is of little or no value as a generic character. The length of the radial vein which in the male *Lipolexis* is said to enclose four-fifths of the radial cell is an unusual character in *Diaeretus* but without other definite characters to go with it is insufficient to separate the genus. *Aclitus* which Foerster separated from *Aphidius* on the ground that the propodium is unareolated and the radius somewhat elongated enclosing two-thirds of the radial cell, is in my opinion untenable since the length of radius is subject to considerable variation in species having the propodium distinctly areolated and in at least one species of *Aphidius* having this vein of normal length the areolation of the propodium is practically effaced. *Paralipsis, Lysiphlebus* and *Diaeretus* are recognizable by the characters given by Foerster and seem to be distinct enough to stand as good genera.

Of the genera placed in this group by Provancher, *Ropronia, Copelus,* and *Arotropus* were later transferred by their author to other groups the two former to the *Proctotrypidae* and the latter to *Formicidae.* [9] *Radiolaria* is placed in the *Daenusinae* by Ashmead. [10] *Aphidaria* was erected for a species which the author later correctly designated a *Praon.*. This should have disposed of the genus but Provancher proceeded to apply the name to another species described by him. This new species, however, proved to be a *Lysiphlebus* so that the genus *Aphidaria* is happily disposed of. *Scotioneurus* originally included two species. Of these one is an *Ephedrus* and the other does not belong in the *Aphidiinae* at all if one may judge by the figure of the wing given by the author. Unfortunately the types of the latter species could not be secured.

Three species were originally included under *Misaphidius.* Judged by the figures given by the author of the genus two of these species fall in *Diaeretus* while the other appears to be a *Lysiphlebus.* *Coclonotus* is obviously a misprint for *Coelonotus,* as pointed out by Dalle Torre. [11] *Protaphidius* being a substitute name for *Coelonotus* becomes a synonym of *Aphidius.*

Dr. Ashmead divided the subfamily into two tribes *Aphidiini* and *Trioxini.* [12] Of the first tribe he says: "This tribe is readily recognized by the hind wings having a distinct basal nervure, the median cell complete." Of the genera placed in this first tribe, to three only can this statement be safely applied, viz: *Ephedrus, Praon* and *Toxares.* In the posterior wing of *Aphidius* the basal nervure is never complete although it can with difficulty be traced by hyaline lines in some species. The median nervure is not infrequently entirely effaced. The same is true of *Diaeretus* and *Monoctonus.*. In species of *Lysiphlebus,* a genus which is placed in the tribe *Trioxini,* the median cell is fully as distinct as in *Aphidius* and *Diaeretus.*. Since the number of genera of *Aphidiinae* is not large and to attempt to maintain the division as proposed by Ashmead can only result in confusion it seems better to discard it altogether. This the writer has done in the following generic synopsis.

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[9] Add. Faun. Canad. Hym., 1888, p. 394.
[10] Proc. U. S. Nat'l Mus., Vol. XXIII, p. 184.
[11] Cat. Hymenop., Vol. IV, p. 4.
[12] Proc. U. S. Nat'l Mus., Vol. XXIII, p. 113.

TABLE OF GENERA OF APHIDIINAE.

1. Forewing with three cubital cells .... 2.
Forewing with less than three cubital cells 3
2. Abdomen rounded at the apex; oviduct bent downward beneath the abdomen.
TOXARES WESTWOOD.
(Type *Toxares deltiger* Hal.).
Abdomen lanceolate: oviduct not bent beneath the abdomen.
EPHEDRUS HALIDAY.
(Type *Ephedrus lacertosus* Hal.).
3. Abdomen rounded at the apex, oviduct bent beneath the abdomen.
MONOCTONUS HALIDAY.
(Type *Monoctonus nervosus* Hal.).
Abdomen lanceolate; oviduct not bent beneath the abdomen .... 4.
4. First cubital and first discoidal cells separated, the first abscissa of cubitus present.
PRAON HALIDAY.
(Type *Praon volucrus* Hal.).

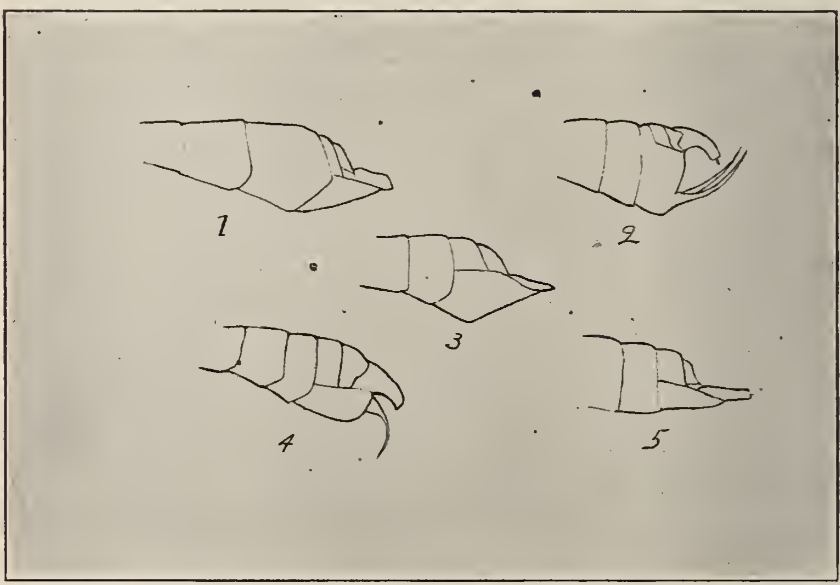

Fig. 3.—Lateral views of typical abdomens representing different genera. 1. *Aphidius rosae.* 2. *Trioxys coruscanigrans.* 3. *Praon simulans.* 4. *Monoctonus paulensis.* 5. *Ephedrus incompletus.* Enlarged.

First cubital and first discoidal cells confluent, the first abscissa of cubitus absent .... 5.
5. Head longer than wide; parapsidal furrows complete.
DYSCRITUS MARSHALL.
(Type *Dyscritus planiceps* Mar.).
Head wider than long; parapsidal furrows usually, though not always absent 6.
6. Forewing with the recurrent nervure, cubital nervure and the cubital crossveins entirely effaced .... 8.
Forewings not as above. With a more or less complete disco-cubital cell.. 7.
7. Disco-cubital cell usually closed, the recurrent nervure always complete and joining cubitus: the cubital crossvein either present or absent.
APHIDIUS NEES.
(Type *Aphidius rosae* Hal.).

Disco-cubital cell always open, the recurrent nervure for the most part effaced. Cubital crossvein usually present. Cubitus always represented by a short stub. LYSIPHLEBUS FOERSTER.
(Type *Aphidius dissolutus* Nees).

8. Radius wholly absent. PARALIPSIS FOERSTER.
(Type *Aphidius enervis* Nees).

Radius present for part of the distance.............................. 9.

9. Female without hornlike appendages on the tip of the abdomen.
DIAERETUS FOERSTER.
(Type *Aphidius leucopterus* Nees).

Female with hornlike appendages on the tip of the abdomen.
TRIOXYS HALIDAY.
(Type *Trioxys aceris* Hal.).

TOXARES.

Trionyx Hal. Ent. Mag. I, 1833, p. 261 and 487: *Toxares* Hal. in Westw. Intro. Mod. Class. Ins., II, 1840, Synop. p. 65.

Head transverse; antennæ, long, many-jointed, palpi rather long. Mesonotum with the parapsidal furrows very indistinct or absent; propodium areolated. Fore-wings with three cubital cells, the first and second cubital crossveins present; first cubital and first discoidal cells separated; subdiscoidal nervure not interstitial. Posterior wing with a distinct basal cell. Abdomen of the female spatulate and flattened, of the male oblong; segments 2-3 the longest, the others short, transverse.

This genus is unknown in North America.

EPHEDRUS.

Haliday, Ent. Mag., I, 1833, pp. 261 and 485.

Syn. *Elassus* Wesm., Nouv. Mem. Acad. Sc. Brux., IX, 1835, p. 85.
Scotioneurus Prov., Add. Faun. Canad. Hym., 1886, pp. 152 & 156.

Head transverse as wide as the thorax; antennæ short, 11 or 12-jointed and the same in both sexes. Mesonotum with the parapsidal furrows incomplete; propodium areolated. Wings (Fig. 4) with three cubital cells, the first and second cubital crossveins present; first cubital and first discoidal cells separated, the recurrent nervure always present; subdiscoidal nervure not quite interstitial. There is always a complete cell in the posterior wing. Abdomen lanceolate and compressed at the apex in the female, spatulate or ovate in the male; the petiole or first segment twice or thrice as long as wide and slightly arched. Ovipositor sheath compressed, rather long and narrow.

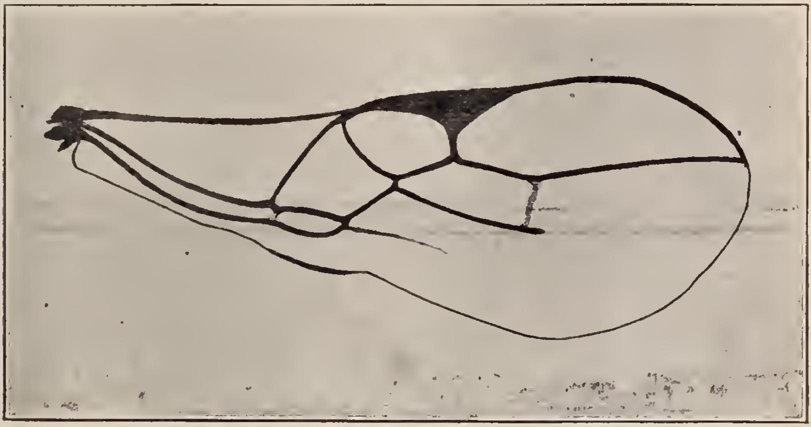

Fig. 4.—Forewing of *Ephedrus incompletus*. Greatly enlarged.

This genus is easily separated from all others except *Toxares* from which it differs in the shape of the female abdomen, *Ephedrus* having it lanceolate and compressed, the ovipositor sheath straight, while in *Toxares* it is rounded posteriorly and the oviduct is bent downward. Three American forms have been described and the description of what is believed to be a fourth species is here included. The males of two of these species are unknown.

Table of Species.

(Females only.)

1. Antennæ 12-jointed .... 2.
   Antennæ 11-jointed .... 3.
2. Antennæ wholly piceus; mandibles black; legs piceus.
   californicus Baker.
   Antennæ yellowish basally; mandibles rufous; legs rufous.
   nevadensis Baker.
3. Antennæ wholly black, mouthparts black, legs dark brown.
   nigricornis n. sp.
   Antennæ with scape and pedicel and more or less of the first flagellar joint yellowish; mouthparts yellowish; legs including coxæ yellow.
   incompletus Prov.

Ephedrus californicus Baker.

Ephedrus californicus Baker, Pom. Jour. Ent., I, 1909, p. 23.

"*Female*:—Length 2.25 mm. Black, polished, legs, antennæ and petiole piceus, bases of tibæ yellowish. Antennæ 12-jointed. Second abscissa of radius equaling first transverso-cubital and first abscissa of cubitus. Mandibles black." (Original description).

I have not seen specimens of this species but it seems to be distinct.

Ephedrus nevadensis Baker.

Ephedrus nevadensis Baker, Pom. Jour. Ent., I, 1909, p. 23.

"*Female*:—Length 2 mm. Black, polished, abdomen and antennae piceus, legs all rufous. Antennae 12-jointed. Second abscissa of radius as long as first abscissa of cubitus, but longer than first transverse cubital. Mandibles rufous.

"*Male*:—Length 1.75 mm. Thorax also piceus. Legs all lemon yellow. Antennae 11-jointed, piceus, second and third joints honey-yellow." (Original description.)

Habitat:—Ormsby County, Nevada.

This species is unknown to me. Either the author has confused two different species in this description or it forms an exception to the rule that the males and females of *Ephedrus* have the same number of antennal joints. The description coincides very well with *E. incompletus* Prov. except in the number of antennal joints.

Ephedrus nigricornis n. sp.

Female:—Length 2.25 mm. Black, smooth, shining. Head including mouthparts deep black and shining. Antennae 11-jointed, black and shining, an annulus between the pedicel and first flagellar joint pale: first flagellar jôint the longest, one-third longer than the second. Thorax entirely smooth, shining, black; the parapsidal furrows distinct anteriorly for about one-third of their length; propodium with distinct median transverse and medium longitudinal carinæ the latter dividing at half its length and forming a rather broad areola just in front of the petiole. All coxæ deep black and shining, remainder of legs dark brown. Wings hyaline the stigma rather narrow, veins and stigma brown. Abdomen longer than the head and thorax, compressed apically, the petiole piceus and rugose, remaining segments shining black with a faint reddish tinge on the sides of apical segments. Ovipositor sheath very slender.

Habitat:—Ft. Collins, Col.

Host:—Unknown.

Described from one specimen received from C. P. Gillette. This specimen is apparently very much like *E. californicus* Baker, but differs in the number of antennal joints. It is my belief that the number of joints is constant in species of this genus but future investigation may show a variation.

Ephedrus incompletus Prov.

Ephedrus incompletus Prov., Add. Faun. Canad. Hym., 1886, p. 156.

Scotioneurus dives Prov., Add. Faun. Canad. Hym., 1886, p. 157.

Ephedrus rosae Withington, Trans. Kans. Acad. Sci., XXVII, 1909, p. 318.

Female:—Length 2 mm. Black, smooth and shining. Head black and shining, mouthparts yellowish: antennae 11-jointed, brown black except scape, pedicel, and more or less of the first flagellar joint which are yellowish: first flagellar joint the longest. Thorax black and shining, the propodium sometimes reddish. Parapsidal grooves apparent at the anterior angles of the mesonotum; propodium areolated as in preceding species. Legs reddish yellow; posterior femoræ and tibiæ brown above, all coxæ brownish. Wings hyaline, veins brown, stigma narrow and brown. Abdomen long, lanceolate; petiole as long as posterior coxæ and half of trochanters, distinctly rugose; all segments including petiole reddish brown. Ovipositor sheath slender, not as long as in preceding species.

Male:—Similar to female except that abdomen is usually darker and the legs more obfuscated.

Habitat:—Canada, Maryland, and Kansas.

Host:—*Myzus cerasi* Fabr., *Macrosiphum rosae* Lin., and *Nectorophora rudbeckiae* Fitch.

The preferred host of this species seems to be the rose aphis since I have reared it several times and in considerable numbers from this host. But two specimens have been secured from the cherry aphis and only one from the cockle-burr aphis. Two cotypes of *E. rosae* With., as well as Withington's description agree perfectly with Provancher's species.

MONOCTONUS.

Haliday, Ent. Mag., I, 1833, pp. 261 and 487.

Head only slightly transverse, nearly cubical. Antennæ with a variable number of joints, usually shorter than the body. Mesonotum with parapsidal furrows effaced except anteriorly. Propodium variable, usually areolated. Forewing (Fig. 5) with the first cubital and first discoidal cells confluent, and forming a disco-cubital cell which is shorter than in *Aphidius* second cubital cell present but incomplete, radial cell incomplete, stigma as in *Aphidius;* first abscissa of radius nearly perpendicular to the stigma; first cubital crossvein jointing the cubital vein directly below the origin of radius, not beyond as in *Aphidius.* Hind wing without a cell. Abdomen rather short and wide, ovate, not compressed posteriorly, the ovipositor and sheath curved sharply downward.

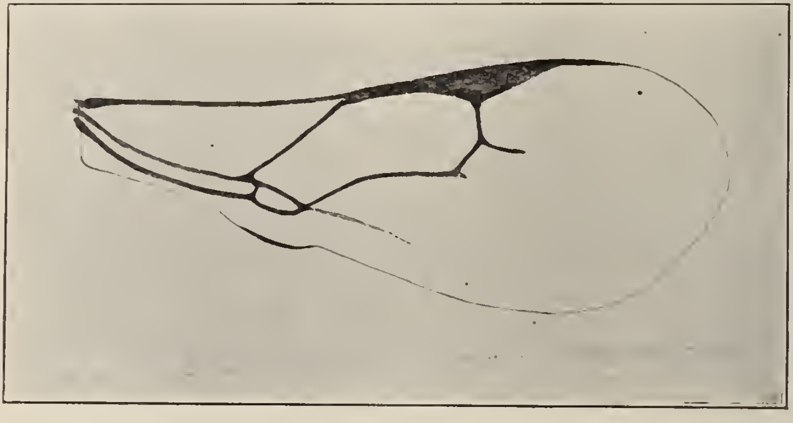

Fig. 5.—Forewing of *Monoctonus paulensis.* Greatly enlarged.

The genus is easily separated from all others except *Toxares* by the character of the ovipositor. From *Toxares* it differs distinctly in the venation of the wings. But one species of the genus is known to exist in the North Americana fauna.

Monoctonus paulensis Ashm.

Aphidius paulensis Ashm., Proc. Wash., Acad. Sci., IV, 1902, p. 246.

Female:—Length 2 mm. Black, shining. Head nearly cubical, temples rather wide and full, clypeus not transverse, as long as wide and set well above the mandibles, face narrow, mouthparts including clypeus yellowish ferruginous, remainder of head black smooth and shining. Antennæ 15-jointed, the first flagellar joint four times as long as thick, the following successively shorter, first five joints slightly yellowish in one specimen but in the other two specimens the whole antennæ is brown black. Thorax wholly black, the parapsidal grooves present anteriorly for about one-third of their length, mesonotum smooth and polished, propodium with very prominent carinæ, the median longitudinal carina dividing at about one-fourth its length from the anterior margin, the two branches enclosing a pentagonal areola as wide at the middle as the base of the petiole, the median transverse carina complete to the lateral margins. Forewings with a large disco-cubital cell, the first abscissa of radius nearly perpendicular to the stigma, the cubital crossvein about as long as the first abscissa of radius and joining the cubital vein directly beneath the origin of radius, the recurrent nervure and cubitus interstitial and slightly curved inward, second discoidal cell complete; stigma rather narrow. Veins and stigma pale brown. Legs dark yellow the posterior coxæ brownish. Abdomen short, no longer than the head and thorax, with a cylindrical, rugose petiole; the ovipositor exserted and like its sheath distinctly curved downward.

Male:—Antennæ 18-jointed, wholly black. The legs are dark brown except at joints. Otherwise the male is like the female.

Habitat:—St. Paul Island, Alaska.

Host:—Unknown.

Redescribed from the Ashmead types.

This species which Ashmead described as an *Aphidius* is without doubt a *Monoctonus*. It agrees both in venation and shape of the ovipositor with Haliday's as well as Marshall's description of that genus. Marshall states that the propodium (metathorax) of *Monoctonus* is unareolated but in this species it is distinctly areolated, the carinæ being more distinct than is usual in the *Aphidiinae*.

PRAON.

Haliday, Ent. Mag. I, 1833, pp. 261 and 483.

Syn. *Aphidaria*. Prov. Add. Faun. Canad. Hym., 1886, p. 151.

Head as wide as long or nearly so, usually narrower than the thorax. Mesonotum gibbous, the parapsidal furrows always present and complete or nearly complete; propodium convex, smooth, without carinæ. Forewings (Fig. 6) with the first cubital and first discoidal separated by the first abscissa of cubitus, the cubital crossveins absent leaving the first cubital cell open; radius never complete to the wing margin; the recurrent nervure sometimes effaced leaving the first discoidal cell open; second discoidal cell usually complete and distinct, the subdiscoidal nervure usually interstitial. Posterior wings with a complete cell. Abdomen lanceolate in the female, spatulate in the male with the petiole broad and rarely much more than twice as long as wide; ovipositor sheath straight, slender and more or less pointed.

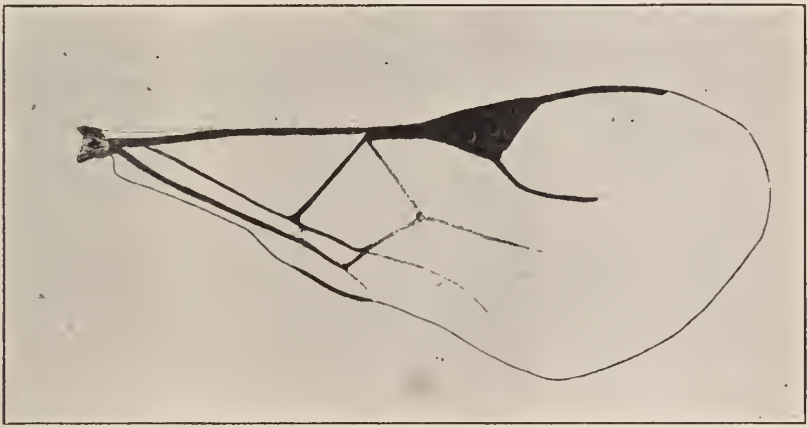

Fig. 6.—Forewing of *Praon coloradensis*. Greatly enlarged.

This genus is easily separated from all others by the character of the wing venation, presence of the parapsidal furrows and the shape of the head. Good specific characters are almost totally lacking, and one is compelled to rely upon slight differences in color to separate species, a most unsatisfactory recourse at best. The males are practically indistinguishable even when placed side by side and consequently are not included in the following table of species. Three species have been described, the females of which are unfortunately unknown. These are *P. nanus* Baker, *P. americanus* Ashm., and *P. cerasaphis* Fitch. The males of *P. alaskensis, P. simulans,* and *P. coloradensis* are also known. The descriptions of all these follow but are given with little hope that they will enable the student to identify them. A character which, at first, it was hoped would serve to separate *nanus* and *americanus* from the other four species was the fact that the recurrent nervure was effaced in these two, but the rearing of a larger series of specimens of *P. simulans* showed that this nervure was absent in many specimens of both sexes and present in about as many and was therefore not even of specific value. It is very probable that both *americanus* and *nanus* are synonyms of *P. simulans* which appears to be a widely distributed species. As the matter now stands the males of *americanus, simulans, coloradensis, cerasaphis* and *nanus* are inseparable on any characters known to me.

TABLE OF SPECIES OF PRAON.

(FEMALES ONLY.)

1. Antennæ entirely black with the exception of a yellowish annulus between the second and third segments......... 2.
Antennæ not entirely black, with the two basal joints and a part at least of the third joint yellowish................. 4.

2. Abdomen entirely testaceous.
occidentalis Baker.
Abdomen not testaceous, either black or blackish.

3. Antennæ 14-16-jointed, legs yellowish.
coloradensis Ashm.
Antennæ with more joints (18-jointed in the type.) Legs ferruginous.
alaskensis Ashm.

4. Prothorax, pleuræ, and propodium bright yellow. Abdomen very slender............................... 5.
Prothorax, pleuræ, and propodium dark, either black or dark ferruginous. Abdomen not so slender................. 6.

5. Head with the cheeks, temples and occiput bright yellow, the vertex black or blackish.
humulaphidis Ashm.
Head entirely black except mouthparts, lower part of cheeks and face below antennæ which are ferruginous.
virginiensis Ashm.

6. Abdomen except the petiole black or brown black: spiracles of the first segment placed near the base and quite prominent.
simulans Prov.

Praon occidentalis Baker.

Praon occidentalis Baker, Pom. Jour. Ent., I, 1909 p. 23.

"*Female*:—Length 2 mm. Black, shining, abdomen entirely testaceous, paler below. Legs including coxæ, clear rufous. Antennæ, 18-jointed, piceus. First and second discoidal cells both distinctly closed. Subdiscoidal nervure not interstitial, but entering second discoidal cell at about one-third its length." (Original description.)

Habitat:—Ormsby County, Nevada.

Host:—Unknown.

I have not seen specimens of this species. The character used in the table of species to separate it from the others is unsatisfactory but the only one offered in the description.

Praon coloradensis Ashm.

Praon coloradensis Ashm., Colo. Biol. Asso., Bull. I, 1890, p. 20.

Female:—Length 1.5 to 2 mm. Black, smooth, shining. Head black, the mandibles yellowish, the palpi brown. Antennæ 14-16- jointed (usually 15-jointed), entirely black except an annulus between the second and third joints. Thorax wholly smooth shining black with thick pubescence on the mesonotum; the parapsidal furrows present; propodium smooth without carinæ. Wings hyaline, veins and stigma dark brown. The recurrent nervure present. Legs including coxæ reddish yellow. Abdomen brown-black, but little longer than the head and thorax; the petiole ferruginous, a little longer than broad, the spiracles near the base and not prominent.

Male:—Antennæ 18-20-jointed; posterior coxæ and femoræ dark brown basally. The abdomen spatulate and scarcely longer than the head and thorax. Otherwise like the female.

Habitat:—Colorado.

Host:—*Chaitophorus negundinis* Thos., *Macrosiphum bicolor* Gillette, and *Nectorophora* sp.

Described from the Ashmead types and twenty specimens received from C. P. Gillette and reared by him from the three above mentioned hosts. The species differs very little from either *alaskensis* or *simulans* except in the number of antennal joints.

Praon alaskensis Ashm.

Praon alaskensis Ashm., Proc. Wash. Acad. Sci., IV, 1902, p. 243.

Female:—Length 2.5 mm. Black, smooth, shining. Head deep black, mouthparts including clypeus ferruginous. Palpi pale. Antennæ 18-jointed, wholly black except an annulus at the suture between the pedicel and first flagellar joint which is pale. Thorax wholly deep black, smooth, and shining: mesonotum pubescent, parapsidal grooves complete: propodium smooth, without carinæ. Wings hyaline, veins and stigma brown, recurrent nervure complete. Legs including coxæ ferruginous the posterior and median coxæ, femoræ and tibiæ brown above. Abdomen including petiole black, slightly longer than the head and thorax.

Male:—Mouthparts darker than in the female. Antennæ 23-jointed. Abdomen spatulate, the petiole faintly wrinkled at the base. Otherwise like the female but with the legs somewhat darker.

Habitat:—St. Paul's Island, Alaska; Corvallis, Oregon.

Host:—Unknown.

The male is described from the two Ashmead types. The female from a single specimen in the United States National Museum from Corvallis, Oregon.

Praon humulaphidis Ashm.

Praon humulaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 657.

Female:—Length 2.5 mm. Smooth, polished. Head bright yellow except the vertex which is blackish: mouthparts pale yellow: antennæ black except the scape, pedicel and most of the third joint which are yellow. Thorax smooth, polished; the parapsidal grooves complete: the propodium convex, smooth; prothorax, pleuræ, and propodium bright yellow, mesonotum and scutellum black. Legs bright yellow. Wings hyaline, stigma and veins pale. Abdomen longer than the head and thorax, very narrow and for the most part yellowish, the dorsum obfuscated.

Habitat:—Richfield Springs, New York; Arlington, Virginia; and Oakland, Maryland.

Host:—Unknown.

Ashmead states that this species was described from a single broken specimen from Richfield Springs, New York. The abdomen, wings, all of the legs and both antennæ of this specimen are broken. There is in the United States National Museum, however, another female specimen bearing the type label and named *Praon humulaphidis* which is in good condition. This specimen is from Arlington, Virginia, and was probably considered a paratype by Dr. Ashmead. Another specimen also in the Museum collection is from Oakland, Maryland, and differs in no way from the type and paratype of Ashmead. The above description is drawn from the three specimens.

Praon virginiensis Ashm.

Praon virginiensis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 607.

Female:—Length 2.5 mm. Smooth, polished. Head black, the mouthparts, lower part of cheeks and face below antennæ ferruginous; antennæ 19-jointed, black with the two basal joints and base of the third yellow. Parapsidal furrows complete; prothorax, pleuræ and propodium bright yellow ferruginous; the mesonotum and scutellum brown-black. Wings hyaline, veins and stigma brown the recurrent nervure present and complete. Legs, including coxæ, all yellowish ferruginous. Abdomen longer than head and thorax, very narrow, the petiole and apical segments laterally, yellow-ferruginous, rest of abdomen brownish.

Habitat:—Arlington, Virginia.

Host:—Unknown.

As in the case of *Praon humulaphidis*, Dr. Ashmead mentions but one specimen as the type of this genus while in the National Museum are two specimens bearing type labels one of which is from the Ashmead collection. Both specimens are from Arlington, Virginia. I am of the opinion that this species and the foregoing are really synonymous. The only difference between them is that the head of *virginiensis* is mostly black while that of the *humulaphidis* is for the most part yellow. The extent of an infuscation varies greatly in many species of *Aphidiinae* and hence is not a true criterion of a species. Dr. Ashmead in his description of *virginiensis* credits the species with a delicate median carina on the propodium or metathorax. The type shows a faint line down the middle of the propodium but it is in no sense a carina and is probably due to the unequal drying of the softer tissues underneath. The paratype of *Praon humulaphidis* as well as the Maryland specimen of that species have an exactly similar line on the propodium. A large series of specimens of either species would probably prove or disprove their synonymy and until such a series can be obtained it is deemed best to keep them separate.

Praon simulans Prov.

Aphidaria simulans Prov., Add. Faun. Canad. Hym., 1886, p. 153.

Praon simulans Prov., Add. Faun. Canad. Hym., 1888, p. 395.

Female:—Length 2 mm. Smooth and polished. Head black and shining above, face below antennæ and lower part of cheeks piceus, mouthparts including clypeus ferruginous, the palpi paler; antennæ 16-20-jointed, the scape, pedicel and first flagellar joint yellowish ferruginous, the remainder brown black. Prothorax, pleuræ usually, and legs dark ferruginous; mesonotum, scutellum and propodium black sometimes slightly piceus: parapsidal grooves distinct, propodium without carinæ. Wings hyaline, veins and stigma brown; the recurrent nervure either present or absent. Petiole smooth with spiracles near the base and quite prominent, ferruginous: remaining segments piceus black. Ovipositor sheath not long.

Male:—Head including cheeks, face, and mandibles black, palpi brownish yellow. Antennæ 18-22-jointed, wholly black, the annulus between second and third joints ferruginous. Prothorax ferruginous; mesothorax, metathorax and propodium deep black. Legs yellowish ferruginous, the median and posterior femoræ above and the apical half of all tarsi brownish. Petiole with prominent spiracles, yellowish brown as is also the second segment: remaining segments black. Otherwise like the female.

Habitat:—Canada, and College Park, Maryland.

Host:—*Siphonophora rudbeckiae* Fitch.

Described from the Provancher type and a large series of specimens reared by the author at College Park, Maryland. The species differs from *virginiensis* but little, being generally darker and the abdomen is broader than in that species.

Species the Females of Which are Unknown.

Praon cerasaphis Fitch.

Trioxys cerasaphis Fitch, 1st & 2nd Rep. Ins. N. Y., 1856, p. 138.

Male:—Length 1.5 mm. Black and smooth. Head black, palpi yellowish. Parapsidal furrows present, the propodium smooth. Legs all yellow very slightly tinged with brown. Wings hyaline the veins and stigma very pale, almost white. Abdomen spatulate, as long as head and thorax, brown black, the petiole ferruginous.

Habitat:—New York.

Host:—Cherry aphis, probably *Myzus cerasi* Fabr.

The type of this species is in very poor condition. It is, however, recognizable as a male *Praon* and differs from males of the other species only in that the legs are somewhat lighter colored. The antennæ are stated by Fitch to be 18-jointed. Repeated attempts by the writer to rear specimens of *Praon* from the cherry aphis have always failed.

Praon americanus Ashm.

Diaeretus americanus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 669.
Diaeretus websteri Ashm., Proc. U. S. Nat'l Mus., 1888, p. 669.
Diaeretus brunneiventrus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 670.

Male:—Length 1.75 mm. Black, smooth, polished. Head black, mouthparts yellowish, the lower part of cheeks sometimes ferruginous; antennæ with 18 or 19 joints, piceus, the two basal joints yellowish beneath. Thorax black above the pleuræ slightly ferruginous; parapsidal furrows complete; propodium without carinæ. Wings hyaline the veins and stigma pale brown, the recurrent nervure is almost entirely effaced. Legs pale ferruginous. Abdomen brownish yellow, about as long as the head and thorax, the petiole a little longer than wide.

Habitat:—Indiana.

Host:—*Siphocoryne avenae*, Fabr.[13]

Dr. Ashmead described this species under three different names, the types of all of which were secured at Lafayette, Indiana, by Professor F. M. Webster. Beyond a very slight variation in the color and a difference of one joint in the antennæ, the types of all three are exactly alike.[13a] I am inclined to think that the species is really a synonym of *P. simulans* Prov., but in the absence of females am uncertain.

Praon nanus Baker.

Praon nanus Baker, Pom. Jour. Ent. I, 1909, p. 23.

"*Male*:—Length 1.75 mm. Black, shining, the legs including coxæ and abdomen, pale rufous, the tarsi and abdomen towards tip becoming piceus. Antennæ piceus. Postmarginal and radial stumps and basal vein about equal in length, the distinct part of cubitus about twice as long. Second discoidal cell not distinctly closed." (Original description.)

Habitat:—Ormsby County, Nevada.

Host:—Unknown.

This species, like *occidentalis*, is unknown to the writer.

APHIDIUS.

Nees Von Esenbeck, Nov. Act. Acad. L. C. 1818, p. 302.

Syn. *Coelonotus* Foerst., Verh. naturh. Ver. Preuss, Rheinl, XIX, 1862, p. 248.

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[13] Ins. Life, III. p. 61.

[13a] Proc. Wash. Ent. Soc., Vol. XII, p. 186.

Theracmion Holmg., Ofvers. Svensk. Vet.-Akad. Forh, XXIX, 1872, Part 6, p. 99.
Coelonotus Thom., Opusc., Entom., P. 20, 1895 p. 2334.
Protaphidius Ashm., Can Ent., XXXII, 1900, p. 368.

Head transverse, as wide or nearly as wide as the thorax, face short, antennæ long and always more than thirteen-jointed. Parapsidal furrows usually but not always absent. Propodium convex or concave and usually distinctly areolated (Fig 8). Wings (Fig. 7) usually hyaline (obfuscated in one species): stigma large triangular or sub-triangular; radius never complete, usually extending less than half the distance to the wing margin; first cubital and first discoidal cells always confluent, forming a disco-cubital cell which is always closed below by the union of the recurrent and cubital nervures but is sometimes open above owing to the partial effacement of the cubital crossvein; second discoidal cell complete and closed; sub-discoidal nervure interstitial; posterior wings usually without a complete cell. Abdomen petiolate, longer than the head and thorax, lanceolate and compressed at the apex in the female, spatulate and rounded at the apex in the male. Ovipositor sheath slightly compressed, short, and protruding from the apex of the abdomen; ovipositor rarely slightly exserted; without hornlike anal processes.

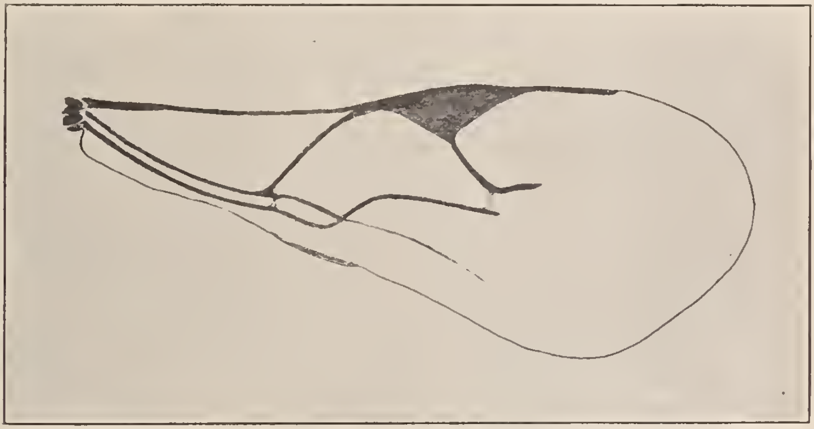

Fig. 7.—Forewing of *Aphidius rosae*. Greatly enlarged.

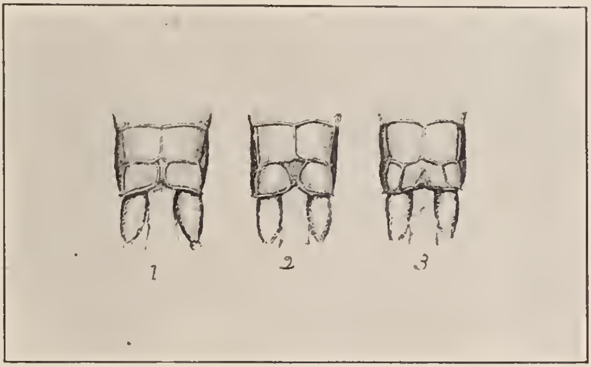

Fig. 8.—Different types of areolation of the propodia in *Aphidius*. 1. *A. rosae*. 2. *A. ribis*. 3. *A. gillettei*. Greatly enlarged.

This genus contains the greater number of described American forms. It can be readily distinguished from any of the other genera except *Lysiphlebus* and *Monoctonus* by the character of the wing venation. From *Lysiphlebus* it is distinguished by having a complete recurrent nervure closing the disco-cubital cell below and by a usually greater number of antennal joints. From *Monoctonus* it may be separated by the shape of the female abdomen and ovipositor.

Table of Species of Aphidius.

1. Wings with two transverse brown bands. *bifasciatus* Ashm.

Wings without transverse bands...................... 2.

2. Mesosternum and mesopleuræ separated by a distinct furrow; parapsidal furrows distinct and deeply impressed. *nigrovarius* Prov.

Mesosternum and mesopleuræ not separated; parapsidal furrows sometimes present but never deeply impressed....... 3.

3. Mesonotum either distinctly punctate or aciculate......... 4.

Mesonotum without distinct punctures or aciculations..... 8.

4. Mesonotum punctate, ... 5.

Mesonotum distinctly aciculate, propodium smooth.........7.

5. Propodium rugose. .... 6.

Propodium smooth. *gillettei n.* sp.

6. Propodium excavate at base of petiole, with transverse ridges within the excavation. Abdominal petiole distinctly thickened dorso-ventrally at the apex. Abdomen twice as long as head and thorax. *bicolor* Ashm.

Propodium excavate but without transverse furrows within the excavation. Apex of petiole not especially thickened. Abdomen not twice as long as head and thorax. *pinaphidis* Ashm.

7. Head and thorax shining black, abdomen brown black. *procephali* Ashm.

Head, thorax and abdomen rufous, the abdomen slightly darker. *macrogaster* Ashm.

8. Propodium with a broad, shallow excavation at the base of the petiole, the excavation bordered in front and at the sides by sharp carinæ. The median longitudinal carina extending only to the anterior border of the excavation............. 9.

Propodium not or only slightly excavated at the base of petiole, the median longitudinal carinæ either wholly absent or dividing at about half its length and enclosing a narrow pentagonal or quadrilateral areola in front of the petiole...10.

9. Head black; prothorax, anterior part of mesopleura and two broad lines corresponding to the parapsidal furrows yellow. Abdomen yellow. Temples sloping rather abruptly from the

eye margin. Abdomen one and one-half times as long as head and thorax and rather robust.
juniperaphidis n. sp.

Head and thorax wholly black, abdominal petiole at base and second and third sutures yellowish, rest of the abdomen dark brown. Temples full rounded. Abdomen nearly twice as long as head and thorax. *californicus* Ashm.

10. Propodium without median longitudinal or median transverse carinæ; with two shallow nearly circular pits, one each side of base of petiole, bordered with very faint carinæ.
xanthus Ashm.

Propodium with distinct but delicate median longitudinal and median transverse carinæ, the former dividing at or before the intersection with the latter and enclosing a narrow pentagonal or quadrilateral areola in front of the petiole......11.

11. Stigma very long and narrow. *atropetiolatus* Ashm.

Stigma normal. ....12.

12. Antennal joints very short, but little longer than wide in either sex. *crassicornis* Ashm.

Antennal joints fully twice as long as wide in both sexes, the basal flagellar joints usually much longer.................13.

13. Legs as well as body very dark, black or nearly so, the anterior pair occasionally lighter............................14.

Legs not black, usually all light yellow, occasionally brownish. ....16.

14. Face extraordinarily wide, clypeus large.
pterocommae Ashm.

Face not so wide, clypeus not large......................15.

15. Face black below antennæ, front femoræ and tibiæ always black. *propinquus* Ashm.

Face usually yellowish below antennæ, anterior femoræ and tibiæ yellowish. *nigripes* Ashm.

16. Whole insect except head bright yellow, the mesonotum and dorsum of abdomen occasionally fuscous. Head black.
polygonaphis Fitch.

Whole insect not bright yellow; the head, mesonotum and propodium always black or brown black..................17.

17. Antennæ of female usually with more than seventeen joints (very rarely with seventeen). Male with twenty or more joints ....18.

Antennæ of female usually with less than seventeen joints (occasionally with seventeen.) Males with twenty or less..20.

18. Antennæ with a very prominent tubercle between the scape and head, appearing as a distinct joint of the antennæ, one-fourth as long as the scape. Hind tibiæ more than usually swollen at the apex. *glacialis* Ashm.

Antennæ on slight tubercles but not nearly so conspicuous. Hind tibiæ less swollen.................................19.

19. Face rather wide, head distinctly transverse, nearly twice as

wide as long, the temples sloping, not full rounded. Abdomen one and one-half times the length of head and thorax. *lachni* Ashm.

Face narrower; head transverse but less than twice as wide as long. The temples rather broad and full, not sloping so abruptly. Abdomen of female twice as long as the head and thorax. *rosae* Hal.

20. Antennæ unusually few jointed, usually with fourteen joints (rarely with fifteen) in the female and sixteen or seventeen in the male. ....23.

Antennæ with a greater number of joints in each sex......21.

21. Petiolar areola narrow and nearly rectangular: maxillary palpi short and rather thick, first, second and third joints not more than twice as long as thick, fourth joint about three times as long as thick................................22.

Petiolar areola broader and distinctly pentagonal: maxillary palpi not long but very slender; second, third and fourth joints four times as long as thick. *ribis* Hal.

22. Hind coxæ and median and hind femoræ brown. *confusus* Ashm.

Hind coxæ and all femoræ yellow. *avenaphis* Fitch.

23. Small brown-black species. *phorodontis* Ashm.

Aphidius bifasciatus Ashm.

Aphidius bifasciatus Ashm., Can. Ent., XXIII, 1891, page 6.

Female:—Length 3 mm. Dull yellow, lustreless. Head much wider than thorax, more than twice as wide as long, the temples very short and abrupt; whole head with the exception of a black spot enclosing the ocelli dull brownish yellow, closely and finely punctured. Antennæ 20-jointed the flagellum black, scape and pedicel brownish yellow. Prothorax, mesonotum and mesopleuræ brownish yellow, entirely lustreless and finely and closely punctured; the propodium darker without carinæ and distinctly hollowed out in front of the abdominal petiole; parapsidal furrows entirely absent. Wings with two dark brown bands, one just below the stigma and the other embracing the basal vein, otherwise hyaline; the disco-cubital cell short and wide. Legs the same color as the mesonotum, the posterior pair slightly darker. Abdomen long and rather narrow, very dark brown, smooth but lustreless. Male unknown.

Habitat:—Florida and Nebraska.

Host:—An aphid on pine.

Described from three specimens in the United States National Museum, one the Ashmead type and the other two from War Bonnet Canon, Nebraska, collected by T. A. Williams.

Aphidius nigrovarius Prov.

Aphidius nigrovarius Prov., Add. Faun. Canad. Hym., 1888, p. 396

Female:—Length 2.5 to 3mm. Head smooth, only slightly shining above, wholly deep yellow except a black spot on the vertex enclosing the ocelli; mouthparts almost white, the palpi slightly fuscous at the joints. Antennæ 21-22-jointed, the scape yellow, the pedicel brownish and the flagellum black. Prothorax, mesopleuræ except the posterior margin, lateral borders of the mesonotum and two lines following the parapsidal grooves, and the scutellum deep yellow; three large spots, one on each of the three lobes of the mesonotum, the posterior border of the mesopleuræ and whole of the metathorax and propodium black. The mesonotum is distinctly punctate anteriorly, smoother posteriorly, the parapsidal furrows distinct and complete; the mesopleuræ are separated from the mesosternum by a distinct furrow; the propodium has a median transverse carina, a median longitudinal which extends from the anterior margin to the transverse carina, and two widely separated longitudinal carina extending from the transverse carina to the posterior margin and bordering a distinct excavation at the base of the petiole; the portion posterior to the transverse carina and the lateral margins are distinctly rugose. The wings are hyaline, the veins and stigma brown. The legs including the coxæ are deep yellow, the tarsi slightly fuscous. Abdomen a little longer than the head and thorax, rather broad, slightly compressed at the apex, the petiole black and distinctly rugose, the following segments smooth and yellow mixed with fuscus on the dorsum and at the apex. Ovipositor sheath rather prominent and yellowish.

Male:—Like the female but with the scape not yellow, the mesonotum with less yellow and the abdomen and tarsi darker. The antennæ in the specimens available are 24-jointed and the propodium is wholly rugose.

Habitat:—California.

Host:—*Lachnus* sp.

This is a handsome and well marked species easily distinguished from all others except *Aphidius bicolor* Ashm. From this species it may be distinguished by the furrow separating the mesosternum and the mesepimeron. Several specimens are in the National Museum labeled "Leland Stanford University" and bearing the above data as to host.

Aphidius gillettei n. sp.

Female:—Length 2.8 mm. Head transverse, more than twice as wide as long, smooth and polished except the vertex which is granularly punctate. Temples not at all rounded but sloping directly from the eye margins; antennæ 21 or 22-jointed, the first joint of scape one and a half times as long as the second, flagellar joints nearly equal, the apical ones slightly shorter. Thorax shining; mesonotum very finely granularly punctate, parapsidal grooves faintly impressed; propodium smooth with a median transverse carina, a median longitudinal carina extending back only as far as the transverse carina, and two widely separated longitudinals reaching from the transverse carina to the apical margin and bordering a shallow excavation in front of the petiole. Legs with the first joint of the hind tarsi slightly shorter than the three following joints combined, second joint one-third longer than the third joint. Forewings with postmarginal vein slightly longer than radius and the second abscissa of radius a trifle longer than the transverse cubital. Abdomen nearly twice as long as head and thorax;

petiole as long as the coxæ and first joint of the trochanter, somewhat wrinkled dorsally; segments beyond the petiole smooth, shining; sheath of ovipositor short and broad. Color: Antennæ black, scape yellow beneath; mandibles white or light yellow tipped with brown; vertex black or piceus; rest of head yellow. Mesosternum, mesepisternum scutellum and propodium black or blackish; rest of thorax yellow. Anterior legs yellow; posterior and middle pairs yellowish brown, lighter at the joints. Basal half of the costal vein, all of the median vein and a patch between the stigma and parastigma whitish; remainder of the stigma and veins dark brown. Abdominal petiole and second segment yellowish, following segments yellowish at the base, darker at the apex; sheath of ovipositor black.

Habitat:—Fort Collins, Colorado.

Described from three females received from C. P. Gillette and reared from *Lachnus* sp. on *Abies lasiocarpa*.

Aphidius bicolor Ashm.

Aphidius bicolor Ashm., Proc. U. S. Nat'l Mus., 1888, p. 658.

Female:—Length 5.5 mm. Dull yellow, shining except on mesonotum and propodium. Head fully twice as wide as long, wider than the thorax, the temples rather abrupt; vertex, occiput and temples piceus; face, cheeks and mouthparts brownish yellow. Antennæ with the scape yellow, the pedicel and flagellum brown black; flagellar joints rather short and thick, scarcely twice as long as wide. Thorax yellow except the propodium which is black; mesonotum punctate, the parapsidal furrows present but not deeply impressed; pleuræ smooth and shining; propodium coarsely rugose, deeply hollowed out in front of the petiole, the excavation bordered at sides and in front with sharp carinæ and with numerous transverse ridges within; the median longitudinal carina reaching only to the forward edge of the excavation, the transverse carina present. Wings hyaline, veins and stigma yellowish brown. Legs unicolorous with the thorax, the tarsi darker. Abdomen very long, twice as long as the head and thorax; petiole black and coarsely rugose, the remaining segments yellowish brown, smooth and shining.

Male:—Unknown.

Habitat:—Washington, D. C.

Host:—Unknown.

Redescribed from a single specimen, the Ashmead type.

Aphidius pinaphidis Ashm.

Aphidius pinaphidis Ashm., Can. Ent., XXIII, 1891, p. 6.

Female:—Length 2.5 to 3 mm. Yellow and only slightly shining. Head wholly brownish yellow, smooth and polished, transverse but little wider than the thorax, the temples rounded. Antennæ 19-jointed, the scape and pedicel yellowish, the flagellum black; flagellar joints short and thick, not over twice as long as wide. Thorax yellow, the propodium sometimes dark brown; mesonotum without parapsidal furrows, punctate with large circular pits; pleuræ smooth impunctate; propodium hollowed out at base of petiole, finely and irregularly rugose, with a median longitudinal carina anteriorly reaching only to the forward edge of the excavation, the transverse carina absent laterally but present on the disc and forming the anterior border of the excavation. Wings hyaline, stigma and veins yellowish brown. Legs unicolorous with the thorax, the tarsi somewhat darker. Abdomen longer than the head and thorax, dorsal segments yellowish brown, more yellowish at sides and below; petiole rugose.

Male:—Antennæ 23-25-jointed; the abdomen not longer than the head and thorax; petiole and propodium coarsely rugose. Otherwise like the female.

Habitat:—Jacksonville, Florida.

Host:—*Lachnus australis* Ashm.

Redescribed from the Ashmead types. The species may be recognized from all others except *bicolor* by the distinctly punctate mesonotum. From *bicolor* it differs principally in having the propodium less deeply hollowed out and without transverse ridges within the excavation. The abdomen of *bicolor* is much longer and the parapsidal grooves are present though very indistinct.

Aphidius procephali Ashm.

Aphidius procephali Ashm., Proc. U. S. Nat'l Mus. 1888, p. 659.

Male:—Length 2.4 mm. Black, smooth and shining. Head transverse, as wide as the thorax at tegulæ; temples not abrupt; whole head smooth, shining black; the mouthparts yellowish. Thorax shining black, the mesonotum with fine aciculations over the whole surface but most pronounced in front of the scutellum and following the parapsidal furrows, which are not deeply impressed; propodium smooth, slightly hollowed out at base of the petiole, the excavation a little wider than the petiole and bordered in front and at sides by sharp carinæ; the median transverse carina is complete forming the anterior border of the excavation, and the median longitudinal extends from the anterior margin to the transverse carina. Wings hyaline, veins and stigma brown. Legs yellowish ferruginous, the median and posterior coxæ brown. Abdominal petiole rugoso-punctate, the following segments brown black and smooth. (Female unknown.)

Habitat:—Washington, D. C.

Host:—*Procephalus* sp., on *Pinus inops*.

Redescribed from the original type. The antennæ of the type are missing but are said by Ashmead to be 26-jointed.

Aphidius macrogaster Ashm.

Aphidius macrogaster Ashm., Can. Ent., XXIII, 1891, p. 5.

Female:—Length 3.5 mm. Dull reddish yellow somewhat shining. Thorax wholly reddish yellow, shining; the parapsidal furrows present but not deeply impressed; mesonotum with numerous parallel acciculations in front of the scutellum and along the parapsidal grooves: pleuræ and propodium smooth, the latter slightly hollowed out in front of the petiole, the excavation twice as wide as base of the petiole, bordered in front and at sides by sharp carinæ; the median transverse carinæ is complete to the margins of the propodium and forms the anterior border of the excavation, the median longitudinal extends from the anterior margin to the transverse carina. Wings hyaline, veins and stigma yellowish brown. Legs slightly lighter colored than the thorax. Abdomen nearly twice as long as the head and thorax, wholly reddish brown.

Male:—Unknown.

Habitat:—Ottawa, Canada.

Host:—Unknown.

Redescribed from the single type, the head of which is missing. Ashmead states that the head is rufous and the antennæ 20-jointed. The species in sculpture of mesonotum and areolation of the propodium differs in no way from *procephali* and it may prove to be the female of that species. It is considerably lighter colored than is *procephali* but that is not uncommonly true of females.

Aphidius juniperaphidis n. sp.

Female:—Head transverse, hardly twice as long as wide, smooth and shining, the temples rather broad and sloping gradually from the eye margins. Antennæ 19 or 20-jointed, the flagellar joints subequal. Thorax smooth and shining, impunctate except for a few coarse punctures on the sides of the metathorax; parapsidal grooves not apparent; propodium with a prominent median transverse carina, a median longitudinal extending from the anterior margin to the median transverse carina, and two widely separated longitudinals reaching from the transverse carina to the apical margin, the space between these latter slightly hollowed out. First joint of posterior tarsi slightly shorter than the three following joints combined, the second joint one-third longer than the third joint. Wings hyaline, the second abscissa of the radius slightly longer than the transverse cubital. Abdomen smooth and shining, the petiole as long as the hind coxæ and trochanters combined and more or less wrinkled. Color: Head black except the mandibles which are yellow and there is often some yellow on the face below the antennæ; scape yellowish beneath, flagellum black. Prothorax, anterior borders and two stripes corresponding to the parapsidal furrows of the mesoscutum, legs, and abdomen yellow; mesoscutum except as stated, scutellum, mesopleuræ, mesosternum and propodium black; stigma and veins dark brown; abdomen yellow, the dorsum slightly fuscous.

Male:—Similar to the female but with more black on the thorax, 22-jointed antennæ, and a shorter and more rugose abdominal petiole.

Habitat:—Boulder, Colorado.

Described from three females and three males received from C. P. Gillette and parasitic on *Lachnus* sp. on *Juniperus sibiricus*.. This species in color is very much like *A. gillettei* but may be distinguished by the absence of any white patch between the stigma and parastigma, by the head being wholly black instead of yellow and by the smooth mesonotum. It is also close to *A. lachni* but may be separated by the areolation of the metathorax.

Aphidius californicus Ashm.

Aphidius californicus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 660.

Female:—Length 2.4 mm. Black, smooth and shining. Head transverse, wider than the thorax, temples rounded, mouthparts yellowish, rest of head black. Antennæ 19-jointed the scape yellowish, flagellum black. Thorax piceus, impunctate, without parapsidal furrows except at the anterior angles; propodium smooth, slightly hollowed out in the front of the petiole, the excavation twice as wide as the base of the petiole and bordered in front and at sides by carinæ, the median transverse carina complete and forming the anterior border of the excavation, the median longitudinal reaching only to the transverse carina. Wings hyaline, the veins and stigma brown. Legs bright yellow except median and posterior coxæ which are brown. Abdomen nearly twice as long as head and thorax, the petiole and second and third sutures yellowish, rest dark brown.

Habitat:—Placer County, California.

Host:—Unknown.

Redescribed from the type. Except in the areolation of the propodium the species is almost exactly like *A. rosae.*

Aphidius xanthus Ashm.

Aphidius xanthus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 661.

Male:—Length 1.4 mm. Yellow, smooth and polished the mesonotum obfuscated. Head transverse, wider than the thorax, the temples rounded, not abrupt; vertex, temples and occiput black; face, cheeks and mouthparts yellowish; antennæ broken, the two basal joints brownish yellow. Thorax yellow smooth and polished, the mesonotum fuscous, the parapsidal furrows present at the anterior angles only; propodium smooth, the transverse and longitudinal carinæ effaced, two shallow circular pits, one each side of the petiole, are bordered with very faint carinæ. Legs unicolorous with the thorax. Wings hyaline, the veins and stigma pale brown. Abdomen as long as the head and thorax, pale yellow, the dorsal segments fuscous at the bases.

Female:—Unknown.

Habitat:—Bushberg, Missouri.

Host:—Unknown.

Redescribed from the Ashmead type. This species in color is very much like *polygonaphis* but seems to differ in having the propodium practically unareolated.

Aphidius atropetiolatus Ashm.

Aphidius atropetiolatus Ashm., Colo. Biol. Assoc., Bul. 1, 1890, p. 20.

Male:—Length 3 mm. Black, smooth, polished. Head nearly cubical, not as wide as the thorax, the temples broad and rounded; clypeus, mandibles, and lower part of cheeks yellowish ferruginous, the palpi dark brown; rest of head deep shining black. Antennæ 23-jointed, the scape yellowish beneath, other joints black; the joints of the flagellum are rather longer than usual in males, about three times as long as wide. Thorax wholly black and polished; the mesonotum impunctate with the parapsidal furrows absent except at the anterior angles; propodium nearly smooth with sharply defined median transverse and median longitudinal carinæ, the latter dividing behind the transverse carina and forming a very small triangular or wedgeshaped areola in front of the petiole. Wings hyaline, the veins and stigma brown, the latter long and very narrow. Legs yellowish ferruginous, the median and hind coxæ and femoræ and all tarsi brownish. Abdomen about as long as the head and thorax, entirely black, the petiole rugoso-punctate.

Female:—Unknown.

Habitat:—Colorado.

Host:—Unknown.

Redescribed from the Ashmead types. The species differs from all others in the very narrow stigma. The head is more nearly cubical than usual in *Aphidius* and the areolation of the propodium is slightly different.

Aphidius crassicornis Ashm.

Aphidius crassicornis Ashm., Can. Ent. XXIII, 1891, p. 5.

Aphidius brevicornis Ashm., Can. Ent. XXIII, 1891, p. 6.

Female:—Length 3 mm. Black smooth and shining. Head transverse, wider than the thorax; the temples full, rounded; face short and broad, the clypeus transverse, three times as wide as long and set well above the mandibles; mouthparts yellowish, the rest of the head black smooth and polished. Antennæ very short scarcely longer than the head and thorax, the flagellar joints very short, but little longer than wide; scape and pedicel yellowish, flagellar joints brown-black. Thorax wholly black smooth and shining; parapsidal furrows effaced except at the anterior angles of mesonotum; propodium smooth, declivous posteriorly but scarcely hollowed out, the median transverse carina present and complete, the median longitudinal dividing at the transverse carina, and enclosing an areola which is nearly as wide as the petiole. Wings hyaline, veins and stigma brown. Legs including coxæ bright yellow. Abdominal petiole slightly rugoso-punctate, the whole abdomen dark brown.

Male:—Antennæ 21-jointed, the joints of flagellum not longer than wide, the posterior and median tibiæ and femoræ brown. Otherwise like the female.

Habitat:—Ottawa, Canada.

Host:—Unknown.

The description of the male is from the original type and that of the female from the specimen mentioned by Ashmead under the manuscript name *brevicornis*. There can be no doubt that the two specimens are of the same species. The species is distinguished from all others by the extraordinarily short flagellar joints and by the width of the clypeus.

Aphidius ptercommæ Ashm.

Aphidius ptercommae Ashm., Proc. U. S. Nat'l Mus., 1888, p. 659.

Male:—Length 3 mm. Black smooth and shining. Head transverse slightly wider than the thorax, the temples wide and sloping but not much rounded: face very wide and hairy, the clypeus slightly wider than long and separated from the face and cheeks by wide deep furrows: mouthparts slightly ferruginous rest of the head black, smooth, polished. Antennæ 21 to 23-jointed, the flagellar joints twice as long as thick, wholly black. Thorax wholly black, smooth, and shining the parapsidal furrows very faintly indicated for about half their length, effaced posteriorly; propodium slightly wrinkled with distinct median transverse carina, the median longitudinal distinct and dividing at the intersection with the transverse carina forming the sides of a small pentagonal areola in front of the petiole. Wings hyaline, veins and stigma dark brown. Legs including coxæ all dark brown. Abdomen dark brown, the petiole slightly rugose basally.

Habitat:—Washington, D. C.

Host:—*Pterocomma salicola* Uhler.

Redescribed from the original types. Distinguished by the width of the face and the character of the clypeus.

Aphidius propinquus Ashm.

Aphidius propinquus Ashm., Trans. Wash. Acad. Sci. IV, 1902, p. 245.

Aphidius frigidus Ashm., Trans. Wash. Acad. Sci. IV, 1902, p. 246.

Female:—Length 3.5 mm. Black, smooth and polished. Head scarcely wider than the thorax, temples broad and more than usually sloping posteriorly, mandibles rufous, palpi black, face hirsute. Antennæ with 16 or 17 joints, entirely black. Thorax deep shining black, smooth except the propodium which is often slightly wrinkled; parapsidal furrows impressed at anterior angles of the mesonotum; propodium with median transverse and median longitudinal carinæ the latter dividing just above the transverse carina and extending as two to the posterior margin, the enclosed areola narrowing perceptibly posteriorly. Legs with the trochanters and joints brown, otherwise deep black. Wings slightly smoky, stigma large, veins coarse; veins and stigma dark brown. Abdomen long, black except at apex where one or two segments are tinged with ferruginous; petiole distinctly rugose on basal half.

Male:—Differs from female only in shape of abdomen and the number of antennal joints, the male having them 20-21-jointed.

Habitat:—St. Paul's Island, Alaska.

Host:—Unknown.

Described from a large number of type specimens in the United States National Museum. The types of *propinquus* and *frigidus* are indentical except that the males of the latter have one less joint to the antennæ. I have no hesitation in pronouncing the latter a synonym. The species is easily recognized by its deep black color and large size.

Aphidius nigripes Ashm.

Aphidius nigripes Ashm., N. Y. State Mus., 47, 1901, p. 588.

Female:—Length 2 mm. Black smooth and shining. Head black except the face below antennæ and the mouthparts which are yellow; palpi usually dark brown. Antennæ 16 or 17-jointed, entirely black. Thorax usually entirely black, occasionally with the prothorax reddish. Parapsidal furrows very faint except at the anterior angles of the mesonotum. Propodium with median transverse and median longitudinal carinæ, the latter dividing at the intersection with the transverse carina and extending as two narrowly separated ridges to the posterior margin; the surface of the propodium posterior to the transverse carina often finely wrinkled. Wings hyaline the veins and stigma dark brown in dried specimens, greenish yellow in fresh specimens. Posterior coxæ black; anterior and median pairs reddish yellow; all trochanters and knees yellowish; the femora, tibiæ, and tarsi are variable, usually very dark brown or black, sometimes the anterior and median pairs are ferruginous. Abdomen usually black with a reddish tinge on the apical segments laterally, occasionally with yellowish bands at the bases of the segments; one and a half times the length of the head and thorax, compressed apically, the petiole slightly rugose.

Male:—Antennæ 18-20-jointed; usually only the clypeus and mouthparts are yellowish; the legs black, and the abdomen wholly black with the petiole distinctly rugoso-punctate.

Habitat:—New York, Maryland, and Colorado.

Host:—*Macrosiphum granaria* Buckton.

This species is most like *A. propinquus* and they can be separated only with difficulty. It is not quite so large and the face and legs show more yellow than does that species. It is a very efficient parasite of the above named grain aphis and was taken in large numbers in the wheat, oats and rye fields at College Park both in 1909 and 1910.

Aphidius polygonaphis Fitch.

Praon polygonaphis Fitch, 1st & 2nd Rept. Ins. N. Y. 1856, p. 136.
Aphidius canadensis Prov., Natur. Canad., 1881, p. 204.
Aphidius obscurus Prov., Add. Faun. Canad. Hym., 1886, p. 156.
Aphidius pallidus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 661.
Aphidius nigriceps Ashm., Can. Ent., XXIII, 1891, p. 6.
Lysiphlebus succineus Vier., Trans. Kans. Acad. Sci., XIX, 1904, p. 282.

Female:—Length 2 to 2.5 mm. Head smooth and shining, black on vertex, occiput and temples; face, lower part of cheeks and mouthparts yellowish, sometimes fuscous. Antennae 17-19-jointed, the scape and pedicel usually yellowish, the flagellum black. Thorax smooth and somewhat shining, honey yellow or succineus, the mesonotum often obfuscated, sometimes nearly black; parapsidal furrows absent except for a very short distance at the anterior angles; propodium with a median transverse carina and a median longitudinal which divides at the intersection with the transverse carina and thence extends as two nearly parallel and narrowly separated ridges to the posterior margin of the propodium. Legs honey yellow, the tarsi somewhat darker. Wings hyaline, veins and stigma brown or brown-black. Abdomen long, lanceolate, compressed at the apex, yellow with the dorsum usually more or less obfuscated, the ovipositor sheath black.

Male:—Similar to the female but with the antennæ 19-23-jointed, the scape and pedical usually dark, the mesonotum and dorsum of the abdomen nearly always obfuscated. Abdomen short and more or less spatulate; the abdominal petiole is slightly roughened in both sexes.

Habitat:—New York, Maryland, Colorado, Canada and Kansas.

Host:—*Macrosiphum rudbeckiae* Fitch, *Siphonophora liriodendri* Monell, and an unknown aphid infesting *Polygonum*.

Fitch's type is plainly an *Aphidius* and differs in no way from the types of *A. canadensis* Prov., *A. pallidus* Ashm., and *A. nigriceps* Ashm. *A. obscurus* Prov., was described from a male specimen of *polygonaphis*. I have seen only the paratype of *L. succineus* Vier. That differs in no way from specimens of this species. The species is a constant parasite of *M. rudbeckiae*, and also appears to commonly attack *Siphonophora liriodendri*. I have reared the species from both of the above named hosts in sonsiderable numbers and in the National Museum are series of specimens from both aphids.

Aphidius glacialis Ashm.

Aphidius glacialis Ashm., Proc. Wash. Acad. Sci., IV, 1902, p. 245.

Female:—Length 3 mm. Black smooth and polished. Head smooth, polished, transverse, about one and a half times as wide as long, temples wide and rounded, face not especially broad, clypeus a little wider than long and well separated from the mandibles, mouthparts excepting clypeus yellowish, remainder of head black. Antennæ brown-black, 19-jointed, two first flagellar joints four times as long as thick, succeeding joints shorter; the tubercles between scape and head unusually prominent, appearing as a distinct joint one-fourth as long as the scape. Mesonotum and pleuræ smooth, shining, the parapsidal furrows absent except at anterior angles: propodium smooth with distinct median transverse and median longitudinal carinæ the latter dividing at about half its length and enclosing a narrow areola at base of petiole. Wings hyaline, the veins brown, stigma pale. Legs including coxæ all yellow; the apices of the hind tibiæ slightly more than usually thickened. Abdomen not much longer than head and thorax, the petiole finely rugoso-punctate and black, remaining segments yellowish brown.

Male:—Unknown.

Habitat:—Juneau, Alaska.

Host:—Unknown.

Redescribed from the type. Except for the characters used in the table of species, this species is like *A. lachni*.

Aphidius lachni Ashm.

Aphidius lachni Ashm., Proc. U. S. Nat'l Mus., 1888, p. 660.

Aphidius montanus Ashm., Colo. Biol. Assoc. Bull. I, 1890, p. 20.

Female:—Length 2.5 mm. Black, smooth, polished. Head transverse, nearly twice as wide as long, the temples rather short only slightly rounded, sloping rather abruptly from the eye margin, face slightly broader than usual, the clypeus about twice as wide as long, only slightly separated from mandibles. Antennæ black, 19-20-jointed, the scape yellowish the three basal joints of flagellum about three times as long as thick, following joints slightly shorter. Prothorax, and mesopleuræ usually ferruginous the rest of thorax black; mesonotum smooth shining, parapsidal furrows absent except at anterior angles, propodium smooth with distinct median transverse and longitudinal carinæ the latter dividing at intersection with the former and enclosing a very narrow, nearly rectangular areola at base of petiole. Wings hyaline, veins and stigma dark brown the cubital crossvein rather short, disco-cubital cell narrowed. Legs including coxæ apically all yellow. Abdomen one and a half times as long as head and thorax, wholly yellowish brown, the petiole rugose.

Male:—Antennæ 20-21-jointed. The joints twice as long as thick. Abdomen no longer than head and thorax. Hind coxæ brown basally. Otherwise like the female.

Habitat:—Alameda County, California.

Host:—*Lachnus* sp., on poplar.

Redescribed from a large number of specimens including the types in the United States National Museum. The species is separated from *A. rosae* with difficulty. Dr. Ashmead called attention in his description of *A. montanus* to its resemblance to *A. Lachni* and then pointed out the differences, principally ones of color and the number of antennal joints. Study of a series of specimens of *lachni* has convinced me that these differences are insufficient to separate th species and I could find no other character which would suffice to hold them apart.

Aphidius rosæ Haliday.

Aphidius rosae Hal., Ent. Mag., I, 1833, p. 261 and II. 1835, p. 97.

Female:—Length 2 to 2.5 mm. Head smooth and shining, transverse, not twice as wide as long, the temples rather broad and rounded; vertex, occiput and temples black; face below antennæ variable, either yellowish or dark brown; mouthparts always pale yellowish. Antennæ 17-20-jointed brown-black, the two basal joints often reddish. Prothorax yellowish, mesothorax and metathorax usually black or dark brown, but sometimes with the mesopleuræ and entire metathorax and propodium yellowish ferruginous; parapsidal furrows absent except at the anterior angles of the mesonotum; propodium with a median transverse and a median longitudinal carina the latter dividing at the intersection with the transverse carina and thence extending as two nearly parallel and narrowly separated ridges to the posterior margin, the enclosed areola, therefore, a narrow quadrilateral. Wings with the stigma and veins brown. Legs yellow or reddish yellow the posterior pair often slightly fuscous. Abdomen twice as long as head and thorax with the petiole reddish yellow, the remaining segments variable, usually brown with yellowish bands at the apices of the segments but often wholly yellow or wholly brown. The ovipositor sheath is always black.

Male:—Darker than the female. Antennæ 20-21-jointed, the flagellar joints near the head distinctly thicker than the following joints. Thorax and abdomen wholly dark brown or black, the petiole slightly lighter. Posterior legs often fuscous. Abdomen spatulate and quite robust.

Habitat:—Maryland and Massachusetts.

Host:—*Macrosiphum rosae* Lin.

Specimens reared from the rose aphis by the writer were sent to Mr. Claude C. Morley of the British Museum who compared them with the Haliday types and pronounced them the same. Several specimens of *Aphidius* reared from the pea louse, *Nectorophora* pisi Kalt, are in the National Museum and are, I believe, this species. Mr. Timberlake has reared the species from the rose aphis at Melrose Highlands, Massachusetts.[14]

Aphidius ribis Haliday.

Aphidius ribis Hal., Entom. Mag., II, 1835, p. 101.

Aphidius ribis Ashm., Proc. Wash. Ent. Soc., IV, 1901, p. 167.

Lysiphlebus ribaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 664

Female:—Length 2 mm. Smooth and somewhat shining. Head transverse, as wide as the thorax and not twice as wide as long, the temples full and distinctly convex; black above on vertex, temples and occiput; cheeks, face below the antennæ, and mouthparts yellow. Antennæ 14-16-jointed with the scape, pedicel, and usually the base of first flagellar joint yellowish, the flagellum brown-black. Prothorax, and metapleuræ yellowish, the mesonotum, scutellum, dorsum of the metathorax, and propodium black; parapsidal furrows apparent for a short distance anteriorly; propodium areolated with a median transverse carina and a median longitudinal, the latter dividing at the intersection with the transverse carina and enclosing a small pentagonal areola at the base of the petiole. Wings hyaline, the veins and stigma light brown. Abdomen more than usually slender, compressed at the apex, with the petiole, the second suture and the greater part of three three apical segments yellowish, the remaining dorsal segments and the ovipositor sheaths black or brown black. Legs entirely yellow.

Male:—Similar to the female but with 17-18-jointed antennæ; the scape usually brown, the prothorax and mesopleuræ usually black, the legs except trochanters and knees reddish brown, and the dorsum of the abdomen except the petiole brown.

Habitat:—Massachusetts, Maryland and Indiana.

Host:—*Myzus ribis* Lin.

Specimens reared at College Park, Maryland, were compared with Ashmead's types of *Aphidius ribis* and found to be the same and were then sent to Mr. C. C. Morley, of the British Museum, who pronounced them the same as Haliday's types. The types of *Lysiphlebus ribaphidis* plainly belong to this species. The species is an important parasite of the currant aphis.

Aphidius confusus Ashm.

Aphidius confusus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 662.

Female:—Length 2 mm. Black, smooth and shining. Head broken off. Thorax smooth and shining the parapsidal grooves present at the anterior angles of mesonotum only, propodium smooth with distinct median transverse and median longitudinal carinæ the latter dividing at the intersection with the transverse carina and enclosing a very narrow rectangular areola at base of petiole. Wings hyaline veins and stigma brown. Anterior legs and all trochanters yellow ferruginous, median and posterior coxæ, femoræ and tibiæ dark brown. Abdomen one and a half times the length of the head and thorax, brownish yellow; the petiole slightly rugose basally.

Habitat:—Los Angeles, California.

Host:—Aphis on orange.

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[14] Psyche, XVII, p. 127.

Redescribed from the type. Ashmead states that the antennæ are 16-jointed and black with the joints of the flagellum about twice as long as thick.

Aphidius avenaphis Fitch.

Praon avenaphis Fitch, 6th Rept. Ins. of N. Y., 1865, p. 98.

Aphidius obscuripes Ashm., Proc. U. S. Nat'l Mus., 1888, p. 660.

Aphidius granariaphis Cook, Can. Ent. XXII, 1890, p. 125.

Female:—Length 2 mm. Brownish-black, smooth, polished. Head transverse but not twice as wide as long, the temples rather broad and distinctly convex. Face not broad; the clypeus small not broader than long, close to the mandibles; the labrum nearly as long as the clypeus and sharply acuminate at the apex; mouthparts including clypeus stramineus, face dull reddish brown to stramineous, rest of the head brown-black. Antennæ 16-17-jointed, wholly brown-black, the flagellar joints about three times as long as thick, shorter apically. Thorax smooth, black or brown-black above, the pleuræ often yellowish or ferruginous; the parapsidal grooves absent except at the anterior angles of the mesonotum; the propodium smooth with well defined transverse and longitudinal carinæ the areola at base of petiole pentagonal and small. Wings hyaline, veins and stigma pale brown. Legs yellowish ferruginous to bright yellow. Abdomen one and a half times as long as the head and thorax, yellowish brown, the petiole smooth or nearly so.

Male:—Antennæ 19-20-jointed; abdomen but little longer than the head and thorax; legs often brown.

Habitat:—Indiana, Michigan, Ohio and Canada.

Host:—*Macrosiphum cerealis* Kalt., and *Siphocoryne avenae* Fabr

The Fitch type of this species is in poor condition but is plainly an *Aphidius*. Besides this type there are in the National Museum a large number of specimens reared from *Siphocoryne avenae* which Dr. Ashmead identified as *Aphidius avenaphis* and which are undoubtedly correctly determined. The types of *A. obscuripes* Ashm., are also accompanied by a series of specimens identified by the author of the species. Dr. Ashmead in referring to *A. avenaphis* has stated that the antennæ were 17-jointed in the female and 20-jointed in the male, and called attention to the variation in the color of the thorax and abdomen. In the series of identified specimens above referred to are females with 16-jointed and others with 17-jointed antennæ, and males having 19 joints and others 20 joints. Among the types and identified specimens of *A. obscuripes* are specimens showing the same variation in antennal joints, although this species is credited with 16 joints in the female and 19 in the male. The two series of specimens show exactly the same variations in color and are identical in every other respect. The *obscuripes* types are somewhat more yellowish on the sides of the thorax and legs than is the rule with *avenaphis* but no more so than in some specimens of that species.

Upon my request for the types of *A. granariaphis* Cook, Professor R. H. Pettit, of the Michigan Agricultural College, sent me two specimens supposed to be the Cook types although they bore no type labels.

Professor Pettit stated that owing to the lack of authentic records he was unable to vouch for the specimens but that the accession showed them to have been collected in 1889 by Professor Cook or one of his assistants and that they were parasitic on *Siphocoryne avenae.* He believed they were the Cook Types. The two specimens received are undoubtedly *A. avenaphis.* The description by Cook agrees well with some specimens of *avenaphis* except in the number of antennal joints of the male. He states that the female of his species has 16 and the male 17-jointed antennæ. The male specimen sent me by Professor Pettit has 19-jointed antennæ. It is probable that Cook mistook a female with 17-jointed antennæ for a male. Considering the agreement of the Cook description with *avenaphis* and the probable authenticity of the specimens sent by Professor Pettit I have little hesitation in placing *granariaphis* as a synonym.

Aphidius phorodontis Ashm.

Aphidius phorodontis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 662.

Female:—Length 1.5 mm. Brownish black, smooth and shining. Head black, transverse, no wider than the thorax, the temples full. Mouthparts including clypeus yellow. Antennæ 14-15-jointed with the scape, pedicel, first flagellar joint and usually more or less of the second and third joints yellowish, the remaining joints brown black. Thorax smooth and shining, the parapsidal furrows absent except at the anterior angles of the mesonotum; propodium areolated as in *Aphidius rosae;* prothorax yellow, mesothorax and metathorax brown-black, often lighter on the mesopleuræ and propodium. Wings hyaline, the veins and stigma light brown. Legs including coxæ all yellow, tips of the tarsi sometimes darker. Abdominal petiole yellow, the remaining segments brown black; abdomen slightly longer than the head and thorax and compressed apically.

Male:—Like the female but with the antennæ 16-18-jointed and wholly brown black; the mouthparts, prothorax and legs darker than in the female, often dark brown. Abdomen scarcely longer than the head and thorax.

Habitat:—Canada and Maryland.

Hosts:—*Phorodon mahaleb* Mon. and *Rhopalsiphum dianthi* Schr.

Redescribed from the types and a series of specimens reared by the writer from *Rhopalosiphum dianthi* at College Park, Maryland. Distinguished from other nearly related species by the fewer jointed antennæ and the smaller size.

DYSCRITUS.

Marshall, Spec. d. Hym. d. Eur., V, 1891, p. 617.

This genus, which was described by Marshall from a single specimen, is unknown in North America. The head is said to be longer than broad, much produced behind the eyes, the occiput not margined. The antennæ are filiform, slender, and many jointed. The parapsidal furrows are complete; the propodium areolated, declivous posteriorly. The wing venation is similar to *Praon* except that the first abscissa of cubitus is absent leaving the first cubital and first discoidal cells confluent: the crossveins are absent; the radius is distinct for one-third of its length; the anal nervure not interstitial. The abdomen is sessile, as long as the head and thorax, strongly compressed posteriorly from the base of the third segment; the terebra very short, its valves stout.

LYSIPHLEBUS.

Foerster, Verh, naturh. Ver. preuss. Rheinl., XIX, p. 248 & 250.

Syn: *Aphidaria* Prov., Add. Faun. Canad. Hym., 1888, p. 396.

Head transverse as wide as the thorax; antennæ with variable number of joints. Mesonotum without parapsidal furrows or with them present for a short distance anteriorly only; propodium areolated or not. Wings with the first cubital and first discoidal cells confluent and always open below (Fig. 9), the recurrent nervure absent or partly effaced; the first cubital crossvein usually distinct; the cubital nervure represented by a short section below the cubital crossvein but never with the first abscissa complete; subdiscoidal nervure interstitial, second discoidal cell complete. Abdomen long lanceolate and compressed at the apex in the female; the male abdomen shorter, flattened, and rounded at the apex.

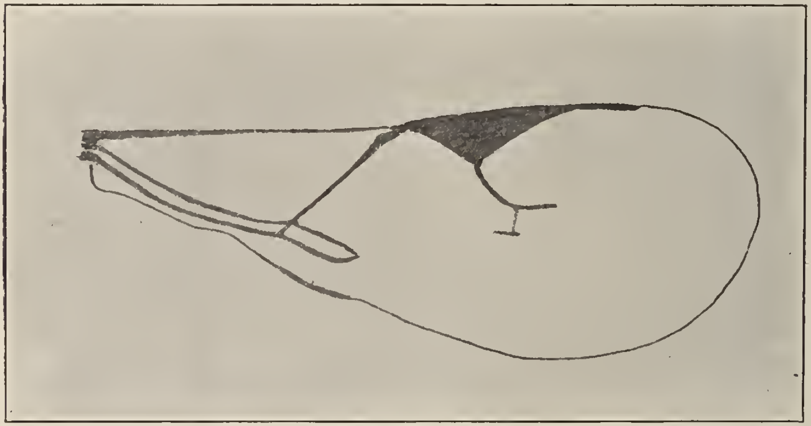

Fig. 9.—Forewing of *Lysiphlebus testaceipes*. Greatly enlarged.

This genus differs from *Aphidius* only in that the disco-cubital cell is not completely closed below, the recurrent nervure being either entirely or for the most part effaced. There has been some doubt expressed as to whether this character is of sufficient stability and importance to justify separation from *Aphidius*. It is a recognizable character and in all of the many hundred of specimens examined has proved constant. It is believed to be good policy to retain generic names where possible to do so without causing confusion and for that reason the genus is retained.

TABLE OF SPECIES OF *Lysiphlebus*.

1. Propodium with distinct though very delicate median longitudinal and median transverse carinæ.................... 2.
   Propodium without carinæ.......................... 3.

2. Mesonotum and scutellum black; prothorax, pleuræ and propodium yellow ferruginous. *multiarticulatus* Ashm.

3. Thorax wholly shining black........................... 5.
Thorax not wholly black, either brownish testaceous or yellow. :.. 4.

4. Head distinctly wider than the thorax at tegulæ; clypeus no wider than long. Color brownish testaceous.
fuscatus Cress.
Head no wider than the thorax; clypeus at least twice as wide as long. Color yellow. *flavidus* n. sp.

5. Antennæ of female 11 to 14-jointed, of male 14 to 16-jointed. Median and posterior legs usually fuscous.
testaceipes Cress.

Lysiphlebus multiarticulatus Ashm.

Lysiphlebus multiarticulatus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 664.

Male:—Length 2 mm. Head transverse, no wider than the thorax, the temples convex, not sloping, and rather broad; the clypeus slightly wider than long; occiput, temples, and vertex black, smooth and shining; lower part of cheeks, face below the antennæ, and mouthparts yellow-ferruginous. Mesonotum and scutellum black and smooth without parapsidal furrows except anteriorly; prothorax, pleuræ and propodium yellow-ferruginous; propodium with distinct but very delicate median transverse and longitudinal carinæ. Wings hyaline the veins and stigma brown. Legs ferruginous, the tibiæ and tarsi fuscous. Abdomen ovate, brown, the petiole yellowish.

Habitat:—Lafayette, Indiana.

Host:—Unknown.

Redescribed from the Ashmead type. The antennæ are broken but are said to be 18-jointed.

Lysiphlebus fuscatus Cress.

Trioxys fuscatus Cress, Proc. Ent. Soc. Philadelphia, IV, 1865, p. 89.

Female:—Length 1.75 mm. Brownish testaceous, smooth, and shining. Head transverse, distinctly wider than the thorax, smooth shining, brownish testaceous, mouthparts pale; the temples narrow and sloping abruptly from the eye margins; clypeus small no wider than long; antennæ 13-jointed and fuscous. Thorax brownish testaceous, smooth and shining, without parapsidal furrows; propodium smooth and unareolated. Wings hyaline, the veins and stigma pale yellowish brown. Legs including the coxæ pale testaceous, the posterior pair slightly fuscous. Abdomen longer than the head and thorax, fusco-testaceous except the petiole which is pale.

Habitat:—Cuba.

Host:—Unknown.

Redescribed from the types in the Philadelphia Academy of Science Museum.

Lysiphlebus flavidus n. sp.

Female:—Length 2 mm. Head smooth, impunctate and somewhat shining with a few hairs on the occiput, temples, and lower part of the face; antennæ 14-jointed, 1st flagellar joint slightly the longest, following joints approximately equal. Thorax smooth, impunctate, somewhat shining and nearly destitute of pile; parapsidal grooves absent except for a very short distance at the humeral angles; propodium without carinæ. Legs hairy; posterior tibial spur small, first tarsal joint as long as the three following joints, the second slightly longer than the third. Forewing with the 2nd discoidal cell distinct and complete. Abdominal petiole slightly rugose basally, narrowest at the base and widening gradually to the apex, spiracles not prominent. Color: Occiput, temples, and cheeks piceus; face, mouthparts and scape beneath, yellowish; flagellum piceus. Thorax reddish yellow with a band of black between the propodium and meso-scutellum. Legs reddish-yellow. Wings hyaline, veins and stigma brown. Abdomen reddish yellow with more or less fuscous at the base of the second and following tergites; ovipositor sheath black.

Habitat:—Fort Collins, Colorado.

Described from three female specimens received from C. P. Gillette and parasitic on *Aphis albipes* Oest.

Lysiphlebus testaceipes Cress.

Trioxys testaceipes Cress., Rept. U. S. Com. Agri., 1879, p. 208.
Aphidius citraphis Ashm., Orange Insects, 1880, p. 76.
Adialytus maidaphidis Garman, 14th Rept. Ill. St. Ent., 1885, p. 31.
Aphidius flavicoxa Ashm., Exp. Sta. Fla. Bull. 2, 1888, p. 23.
Aphidaria basilaris Prov., Add. Faun. Can. Hym., 1888, p. 396.
Lysiphlebus piceiventris Ashm., Proc. U. S. Nat'l Mus., 1888, p. 664.
Lysiphlebus eragrostaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 665.
Lysiphlebus coquilletti Ashm., Proc. U. S. Nat'l Mus., 1888, p. 665.
Lysiphlebus curcurbitaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 665.
Lysiphlebus persicaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 668.
Lysiphlebus myzi Ashm., Proc. U. S. Nat'l Mus., 1888, p. 666.
Lysiphlebus gossypii Ashm., Proc. U. S. Nat'l Mus., 1888, p. 667.
Lysiphlebus abutilaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 667.
Lysiphlebus tritici Ashm., Proc. U. S. Nat'l Mus., 1888, p. 668.
Lysiphlebus baccarhaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 668.
Lysiphlebus minutus Ashm., Proc. U. S. Nat'l Mus., 1888, p. 664.
Aphidius persiaphis Cook, Mich. Agri. Coll. Bull. 73, 1891, p. 21.
Lysiphlebus crawfordi Rohw. Trans. Amer. Ent. Soc. XXXV. 1909, p. 135.

Female:—Length about 2 mm. Head distinctly transverse, as wide as the thorax at the tegulæ, black, smooth and shining; the temples convex, not broad; clypeus transverse, about twice as wide as long; mouthparts usually yellowish, occasionally fuscous. Antennæ 11-13-jointed, (usually with 13 joints) black or brown-black, the joints approximately equal in length throughout and about twice as long as thick; the two apical joints are sometimes connate, forming a single joint much longer than the others. Thorax black, smooth and shining, the parapsidal furrows absent or only faintly indicated at the anterior angles of the mesonotum, the propodium flattened or depressed posteriorly, the spiracles visible but not prominent. Wings hyaline, veins and stigma brown; the stub of cubitus varies somewhat in length but is never longer than the crossvein, usually shorter; the cubital crossvein is often indistinct, lacking the pigment, but can always be traced by a hyaline fold. Forelegs including their coxæ yellow; middle and posterior coxæ, femoræ, and tibiæ, usually though not always fuscous, often nearly clear yellow. Abdomen lanceolate, compressed at the apex, about one and a half times as long as the head and thorax, black or brown-black, except the petiole which is usually yellow; the ovipositor sheath black.

Male:—Antennæ 14-15-jointed the joints slightly shorter than in the female. Abdomen scarcely longer than the head and thorax, rounded at the apex. Middle and posterior legs usually fuscous, occasionally clear yellow. In other respects the male is like the female.

Habitat:—United tates.

Host:—*Aphis gossypii* Glov., *Aphis maidis* Fitch., *Toxoptera graminum* Rond., *Siphonophora curcurbitae* Middleton, *Myzus ribis* Lin., *Siphocoryne avenae* Fabr., *Macrosiphum rosae* Reaum. *Aphis setariae* Thos., *Aphis brassicae* Lin., *Rhopalosiphum dianthi* Schr., *Aphis maidiradicis* Forbes, *Aphis medicaginis* Koch., *Aphis heraclii* Cowen, *Myzus cerasi* Fabr., *Macrosiphum granaria* Kalt.

Of the above list of synonyms six were placed in synonymy with *L. citraphis* by Mr. D. W. Coquillet[14].[a] The Writer recently published his reason for believing *L. citraphis* with its synonyms a synonym of *L. testaceipes*.[14b]. The remaining names are here added to the synonymy for the first time. That my conclusions in regard to a number of these names will be questioned by some I have little doubt. With the exception of *Aphidius flavicoxa* they have been so placed, however, only after the most careful examination, not only of the types but in many cases of large series of specimens reared from the same hosts as those to which the types have been credited. Dozens of specimens of *Lysiplebus* reared from *Aphis gossypii* both dry-mounted and in bolsam have been compared with similar series of the parasites of *Toxoptera graminum* and *Aphis maidis* and not a single character could be found in the one that was not exactly duplicated in the others. In the pursuit of some point of dissimilarity which would serve to separate them, numerous mounts were made of the mouthparts and genitalia of both males and females but with only negative results. So far as I am able to determine there is absolutely no difference structurally nor even an appreciable one in color between the parasites of these three hosts.

14a. Ins. Life, III, p. 315.

14b. Proc. Wash. Ent. Soc., XII, p. 183.

Material was not available for a similar study of the others but in all but three cases the number of type specimens was large enough to furnish considerable series for examination. These types were all mounted on points and, of course, had to be studied in that condition. In the case of *L. gossypii* which was described from the same host as was *L. testaceipes* there are about thirty specimens in the type series. Among these are many which are exact duplicates of the types of *L. testaceipes*. The others differ only slightly in color and size probably due to having been reared under unfavorable conditions. The type series of *L. minutus* and *L. cucurbitaphidis* are also ample. The former, also a parasite of *A. gossypii* appear to be simply attenuated specimens of *L. testaceipes* differing in no way except size. It is not an uncommon experience in rearing specimens in the laboratory under unnatural conditions to find them not fully and normally developed. The types of *L. cucurbitaphidis* and *L. myzi* apparently are exactly like those of *L, testaceipes*. The types of *Aphidius flavicoxa* could not be located and are probably lost, but from the description and host I have no hesitation in placing it here along with *L. maidaphidis* from which Ashmead separates it entirely on the color of the hind coxæ.

Only one type specimen of *L. persicaphidis* was available for study. This specimen shows no character that cannot be duplicated in a series of specimens from the cotton aphis. The same is true of *A. persiaphis* of which one type and two cotypes were examined. The author of *L. crawfordi* confused two different genera in his description of that species. He called attention to the fact that the wing venation of a part of the type specimens placed them in the genus *Lysiphlebus* while others ran to the genus *Lipolexis* which is a synonym of *Diaeretus*.. In the National Museum are five specimens running to the latter genus and one female running to the former. Aside from the differences in venation the *Lysiphlebus* specimen has an entirely unareolated propodium while the females with the venation of *Diaeretus* have quite distinct longitudinal and transverse carinæ. In the study of many large series of both *Lysiphlebus* and *Diaeretus* the writer has never found evidence that the venation in either varied to any great extent, certainly not to the extent shown in these specimens. The *Diaeretus* specimens agree in every way with *D. chenopodiaphidis* and the *Lysiphlebus* specimen is indistinguishable from *L. testaceipes*.

Dr. Ashmead who was responsible for most of the names here placed in synonymy apparently believed as I have already pointed out, that each species of *Aphidiinae* was confined in its parasitism to a single host and that the number of antennal joints was constant for any given species. To these two ideas of his can chiefly be laid the numerous duplicate descriptions of this parasite. That he was wrong in regard to the number of antennal joints has been amply proven. For some reason many American entomologists have seemed loathe to oppose the view that a species would not parasitize more than one host, despite the fact that species of other groups of parasitic *Hymenoptera* are known to infest several hosts and European writers have in a number of instances credited species of *Aphidiinae* to several hosts. There seems to be no good reason why the species of this group should be considered to be so restricted in the matter of hosts. It is far more reasonable to believe that one species of *Lysiphlebus* parasitizes fifteen or twenty or more species of aphids of very similar habits and found under similar environment than to suppose that we have a like number of species of *Lysiphlebus* which display, absolutely no character by which they can be recognized.

In spite of the fact that I am unable to find structural characters which will keep them apart I would hesitate, however, to declare this list of synonyms without other evidence to bear it out. It has been demonstrated by Professor F. M. Webster that the *Lysiphlebus* parasites of *Aphis gossypii, Aphis maidis, Aphis maidiradicis, Aphis brassicae* and *Aphis setariae* can breed successfully in *Toxoptera graminum* and conversely he has introduced successfully the parasite of *Toxoptera* upon several if not all of the above species of aphids.[15] Prof. S. J. Hunter has also successfully bred the parasite of *Toxoptera* into *Siphocoryne avenae* and *Macrosiphum granaria*. He records *Macrosiphum granaria* as attacked in the field by the same parasite. ([16])

These records show plainly that a species of *Lysiphlebus* is not limited to one host but will breed successfully in a number of different hosts. With this fact established and knowing that the *Lysiphlebus* parasites of a large number of aphids reared under natural conditions are inseparable by any morphologic characters, showing the same variations in color as well as other respects, there is no good reason for believing that they do not all represent the same species. It is further, a well known fact that widely separated outbreaks of any of the aphids which are effectively preyed upon by *Lysiphlebus* parasites of this type are almost invariably suppressed by a horde of these parasites as soon as weather conditions become favorable for their development. This can only be satisfactorily explained on the theory that the species maintains a general distribution on a number of different hosts.

All of the hosts included in the above list except *Aphis medicaginis, Aphis heraclii,* and *Myzus cerasi* have been previously recorded as hosts of either one or the other of the synonyms. Professor C. P. Gillette sent me among other *Aphidiinae* a large series of *Lysiphlebus* reared by him from *Aphis medicaginis* as well as another smaller series reared from *Aphis heraclii*. I have myself reared a series of *Lysiphlebus* from *Myzus cerasi*. In each instance the parasites are indistinguishable from *L. testaceipes*.

PARALIPSIS.

Foerster, Verh. naturh. Ver. preuss. Rheinl. XIX, 1862, p. 248 and 250.

This genus is not known to exist in North America. It can be distinguished from all the other genera by the total absence of the radial vein.

DIAERETUS.

Foerster, Verh. naturh. Ver. preuss. Rheinl. XIX, 1862, p. 249, and 250.

Syn. *Adialytus* Foerst., Verh. naturh. Ver. preuss. Rheinl. XIX, 1862, p. 249 and 250.

Lipolexis Foerst., Verh. naturh. Ver. preuss. Rheinl., XIX, 1862, p. 249 and 250.

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[15] Ann. Ent. Soc. Amer. Vol. II, p. 85.

[16] Bull. Univ. Kans., Vol. 9, No. 2, p. 150.

Misaphidius Rond., Bull. Soc. Ent. Ital., IX, 1877, p. 185.

Head transverse as wide as the thorax. Antennæ with a variable number of joints. Mesonotum with parapsidal furrows indicated only anteriorly; propodium usually areolated. Anterior wings (Fig. 10), with the cubital cells and first discoidal cell obsolete; second discoidal cell present or absent; radial nervure not complete to the apex of the wing, the cubital vein, recurrent nervure and crossveins effaced; posterior wings without a complete cell. Abdomen petiolate, lanceolate, and compressed posteriorly in the female without hornlike processes at the apex; in the male short and rounded posteriorly.

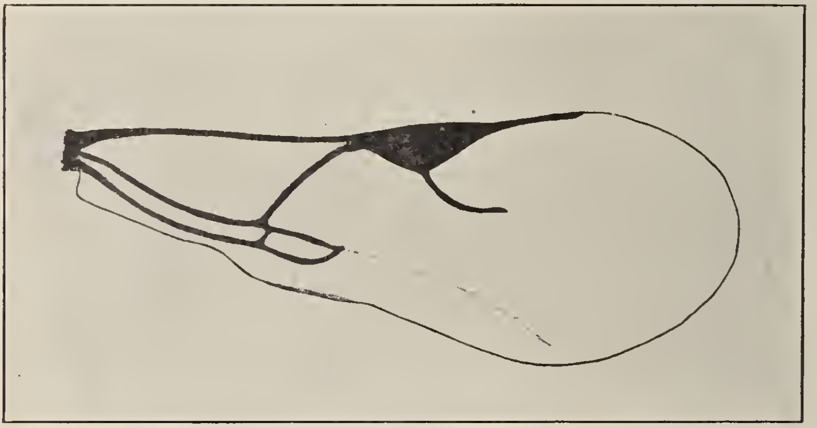

Fig. 10.—Forewing of *Diaeretus rapae*. Greatly enlarged.

Four species occurring in America have been described. The genus is separated from *Trioxys* by the absence in the female of hornlike anal processes. From the other genera it is distinguishable by the character of the wing venation.

TABLE OF SPECIES OF *Diaeretus*. (Females.)

1. Radial and postmarginal veins elongate, enclosing two-thirds of the radial cell. Antennæ of female with twelve joints.
fusicornis Ashm.
Radial and postmarginal veins shorter, enclosing less than half the radial cell. Antennæ of female with more than twelve joints. . . . . 2.

2. Legs fuscous, the median and posterior pairs almost black. Abdominal petiole black or dark brown. . . . . 3.
Legs not so dark, honey-yellow or reddish, the abdominal petiole yellowish. . . . . 4.

3. Antennæ of female usually with 14 or 15 joints, very rarely with 13. Male with 16 or 17 joints. Usually with a narrow but distinct median areola in front of the petiole.
rapae Curt.
Antennæ of female with 13 joints. Male with 16. Without a distinct median areola in front of the petiole.
chenopodiaphidis Ashm.

4. Legs almost wholly yellow, the posterior pair with the femoræ slightly obfuscated. Antennæ 13-jointed in the female, 15 or 16 in the male. *salicaphis* Fitch.

Diaeretus fusicornis Ashm.

Lipolexis fusicornis Ashm., Can. Ent., XXIII, 1891, p. 7.

Female:—Length 2 mm. Black, smooth, slightly shining. Head brown, the mouthparts yellowish, clypeus and face below antennæ reddish. Antennæ 12-jointed, short, the last joint slightly thickened, the scape and pedicel and base of first flagellar joint pale yellow, rest of flagellum brown. Thorax wholly brownish black, nearly opaque; the parapsidal furrows very faintly impressed at the anterior angles; the propodium smooth, apparently without a transverse carina. (The specimen is mounted in such a manner that only one side of the propodium is visible.) Wings hyaline, the veins and stigma brown; second discoidal cell complete and distinct: the radius elongate, traceable to the wing apex but abruptly narrowed at half its length the apical half represented by a hirsute line: postmarginal vein also elongate reaching nearly to the apex of the wing. Legs including the coxæ all pale testaceous. Abdomen scarcely longer than the head and thorax, the petiole and second segment pale testaceous, remaining segments brown black. Male unknown.

Habitat:—Ottawa, Canada.

Host:—Unknown.

Redescribed from Ashmead's type, a single female. Readily recognized by the elongate radial and postmarginal veins and by the wholly testaceous legs.

Diaeretus rapæ Curt.

Aphidius rapae Curt., MacIntosh's Book of the Garden II, 1855, p. 194.

Trioxys piceus Cress., Rep't. U. S. Com. Agri., 1879, p. 260.

Aphidius brassicae Marsh., Spec. d. Hymen. d. Eur. IV, 1891, p. 615.

Diaeretus californicus Baker, Pom. Jour. Ent., I, 1909, p. 23.

Female:—Length 2 mm. Head and thorax black, smooth and shining. Head transverse not wider than the thorax, the temples rather broad and convex, not sloping abruptly from the eye margin, clypeus transverse, about twice as wide as long. Mouthparts reddish yellow the palpi often fuscous. Antennæ 13-15-jointed, (most often 14-jointed) entirely black or dark brown. Parapsidal furrows present at the anterior lateral angles of the mesonotum; propodium with distinct median longitudinal and transverse carinæ, the former dividing at the intersection with the latter and enclosing a short and very narrow areola at the base of the petiole, (this areola is variable in width being hardly discernible in some specimens.) Wings hyaline, veins and stigma brown; the postmarginal vein and the stub of radius are nearly equal, the latter extending about one-third of the distance to the wing apex; the cubital vein recurrent nervure and cubital cross-veins are entirely effaced. Anterior legs including their coxæ yellow; median and hind coxæ mostly black, yellowish at the apices, their femora and tibiæ brownish; tarsi all fuscous. Abdomen longer than the head and thorax, often entirely black but usually reddish brown.

Male:—Antennæ 16-18-jointed. All legs usually dark brown, nearly black. Abdomen not longer than the head and thorax. Otherwise similar to the female.

Habitat:—United States and Europe.

Host:—*Aphis brassicae* Lin.

Described from a large series of specimens reared by the writer. Although I have not seen the type of *D. californicus* Baker I am led to believe it a synonym of this species by the fact that the description differs in no way from *rapae* which is known to exist in California and by the further statement of Baker that his specimens were reared from an aphis infesting wild mustard which is a common host plant of *Aphis brassicae*. The other cases of synonymy and reasons for same were given in a previous paper.[17]

Diaeretus chenopodiaphidis Ashm.

Lipolexis chenopodiaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 671.

Female:—Length 2 mm. Black, smooth, shining. Head black the mouthparts including clypeus yellow. Antennæ 13-jointed, the scape and pedicel yellowish beneath, flagellum brown-black. Thorax wholly black with a slightly reddish tinge on the propodium; parapsidal furrows impressed at anterior angles of the mesonotum; propodium with median transverse and median longitudinal carinæ, the latter not divided posteriorly, consequently with no areola at the base of the petiole. Wings hyaline, veins and stigma brown; second discoidal cell complete and distinct, the radius extending about one-third the distance to the wing apex. Posterior coxæ and femoræ and median femoræ above brownish, rest of the legs yellowish. Abdomen longer than head and thorax, brown or reddish brown.

Male:—Similar to the female but with the antennæ 16-jointed, less evidently yellowish basally; the legs all dark brown.

Habitat:—California.

Host:—An aphis infesting *Chenopodium album*.

Redescribed from the Ashmead types. Hardly distinguishable from *rapae* but with the antennæ apparently typically 13-jointed instead of 14-jointed as in *rapae*. The legs are also somewhat more yellowish in the female than is the case with *rapae*, and the propodium is without a distinct areola before the base of the petiole.

Diaeretus salicaphis Fitch.

Trioxys salicaphis Fitch, 1st & 2nd Rep't Ins. N. Y., 1856, p. 137.

Trioxys populaphis Fitch, 1st & 2nd Rep't Ins. N. Y., 1856, p. 137.

Lipolexis salicaphidis Ashm., Proc. U. S. Nat'l Mus., 1888, p. 671.

Male and female:—Length 1.5 mm. Head smooth and shining, antennæ thirteen of fourteen jointed, the joints of the pedicel globose and equal, those of the flagellum about twice as long as wide, equal throughout, slightly fluted and pubescent. Thorax smooth and shin-

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17. Proc. Ent. Soc. Wash., Vol. XII, p. 181.

ing, impunctate; parapsidal grooves absent except for a very short distance anteriorly; propodium smooth with very delicate median longitudinal and transverse carinæ. Legs hairy; posterior basal tarsal joint as long as three following joints, the second, one and a half times the length of the third; the basal joint of the median tarsi as long as the two following joints. Wings hyaline, 2nd discoidal cell complete but faint, radius arising slightly anterior to the middle of the stigma, shorter than the postmarginal. Abdomen nearly twice as long as the head and thorax, smooth, shining; the petiole shorter than the posterior coxæ and trochanters combined, narrowest at the base, the spiracles before the middle and not prominent. The male has 15 or 16-jointed antennæ and a somewhat shorter abdominal petiole and abdomen than the female.

The color in this species is variable to a remarkable degree. In the male the head above, flagellum, mesonotum, most of the mesopleuræ, the metathorax, and more or less of the hind coxæ and abdomen are always dark piceus or black. The legs and abdominal petiole are always yellowish. The face, scape of the antennæ, prothorax, anterior part of the mesopleura, and second to fourth segment of the abdomen vary in different specimens from testaceous to piceus. The female shows a much greater degree of variation, some specimens being entirely testaceous with the exception of the occiput, temples, eyes and flagellum, which are always black or very dark piceus, while other specimens are almost entirely black, having only the legs and base of the abdomen yellowish.

Habitat:—New York, California and Colorado.

Host:—*Chaitophorus populicola* Thos.

Described from Ashmead and Fitch types and twenty-three specimens received from C. P. Gillette, reared from the above mentioned plant louse. This lot of twenty-three specimens represented three different rearings and each series showed the same remarkable variation in color. The Fitch and Ashmead types are identical in every way.

TRIOXYS.

Haliday, Ent. Mag., I, 1933, p. 261 and 488.

Syn. *Neuropenes* Prov., Add., Faun. Canad. Hym., 1886, p. 151 and 153.

Head transverse as wide as the thorax; antennæ short, usually 11-jointed in the female and 13-jointed in the male, (Marshall states that some females have 10 and some 12 joints.) Mesonotum with parapsidal furrows indicated only anteriorly; propodium usually areolated. Anterior wing with the cubital cells and the first discoidal cell obsolete, the cubital nervure, cubital crossveins, and the recurrent nervure effaced (Fig. 11). The second discoidal cell may be complete or incomplete. Radial nervure extending not over half the distance to the wing apex. Without a distinct cell in the posterior wing. Abdominal petiole narrow; female abdomen lanceolate, compressed posteriorly with a pair of hornlike appendages longer than the terebra at the lower extremity; the terebra bent downward between the horns. Male abdomen short and rounded at the apex.

The wing venation of *Trioxys* is exactly like that of *Diaeretus* and the males of the two genera are indistinguishable. The females can only be separated by the presence of the hornlike processes at the apex of the abdomen in *Trioxys* and their absence in *Diaeretus*.

Three species have been recorded in America and the description of a fourth is given here.

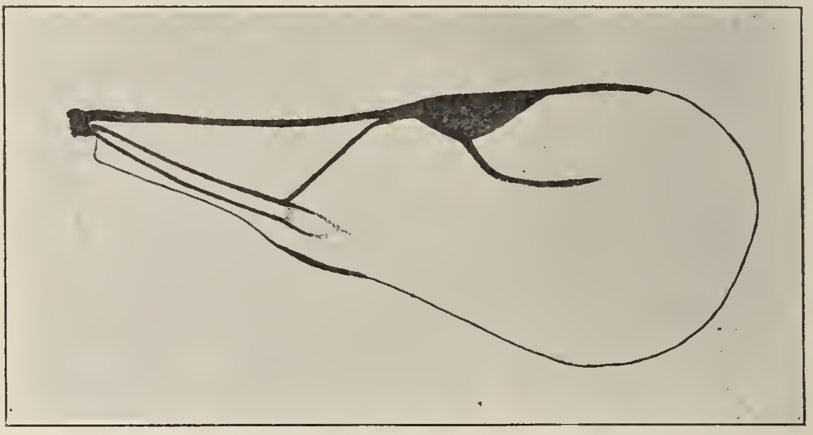

Fig. 11.—Forewing of *Trioxys aceris.* Greatly enlarged.

TABLE OF SPECIES OF *Trioxys*.

1. Second discoidal cell complete and distinct.............. 2.
Second discoidal cell incomplete or very indistinct....... 3.
2.. Abdominal petiole constricted at base and apex, enlarged in the middle. Three basal joints of antennæ, and legs yellowish. Abdomen rufo-piceus with the apex yellow.
rhagii Ashm.
Abdominal petiole with sides parallel. Antennæ and legs black. Abdomen black except apical one-fourth which is yellowish. *coruscanigrans* n. sp.
3. Posterior and median tibiæ and femoræ dark brown, nearly black. Medium sized species with the three basal joints of the antennæ and the apex of the abdomen testaceous.
aceris Hal.
All legs rufous. Minute species with the petiole of the abdomen clear yellow and with prothorax and ventral part of mesothorax yellowish. *ovalis* Prov.

Trioxys rhagii Ashm.

Trioxys rhagii Ashm., Proc. U. S. Nat'l Mus., 1888, p. 670.

Female:—Length 2.6 mm. Head transverse, as wide as the thorax, brown-black above, the face below antennæ and lower part of cheeks reddish brown, the clypeus and mouthparts yellowish. Antennæ 11-jointed, brown-black; the scape, pedicel, and first flagellar joint pale yellow. Thorax entirely smooth and shining, brown-black, the parapsidal furrows impressed at the anterior angles, effaced posteriorly: propodium convex, with median longitudinal and median transverse carinæ the former dividing at half its length and enclosing a pentagonal area at the base of the petiole: posterior half of the propodium faintly punctate or wrinkled. Wings hyaline, the stigma and radial stump very pale, almost hyaline, the costal and basal veins brown; second discoidal cell complete and distinct. Legs yellow, the median and posterior coxæ dark brown at base. Abdomen nearly twice as long as head and thorax, the spiracles of the first segment placed much behind the middle and very prominent, sharply constricted behind the spiracles; the anal processes much longer than the ovipositor sheath, the latter sharply bent downward, the ovipositor exserted; sides of petiole, first and second dorsal sutures and the apical segments laterally pale yellowish, remainder of abdomen reddish brown.

Habitat:—New Jersey.

Host:—According to Ashmead, reared from a beetle, *Rhagium lineatum.*

Redescribed from Ashmead's type. Much like *aceris* but larger, not so dark, and with the spiracles of the petiole more prominent and placed more posteriorly.

Trioxys coruscanigrans n. sp.

Female:—Length 2 mm. Head entirely black, smooth, and polished with a few scattering white hairs on the occiput, temples, and cheeks and a row of white hairs bordering the clypeus anteriorly; mandibles faintly piceus; antennæ black, shining, sparsely hairy, 11-jointed, the flagellar joints not fluted, the first joint about three times as long as thick, the following joints to the penultimate decreasing slightly in length, the last joint longest, (in one specimen the last joint is partially divided indicating that some specimens may have 12-jointed antennæ.) Prothorax and mesothorax black, smooth, and shining, impunctured and destitute of pile, the parapsidal grooves apparent at the anterior humeral angles for a short distance; metathorax smooth, shining, black, with a very faint and indistinct areolation; legs uniformly dark piceus, almost black. Wings hyaline, irridescent, costa and basal veins dark, stigma and other veins somewhat lighter, the stigma short and thick with the radius arising from the middle and twice as long as the postmarginal; the second discoidal cell complete and distinct. Abdomen a little longer than head and thorax together, the petiole and following tergites somewhat piceus, the anal one-fourth of the abdomen yellow especially laterally and below; the sheath of ovipositor piceus and bent sharply downward between the long anal prongs, the apices of which are likewise piceus; the ovipositor slightly exserted and yellowish.

Habitat:—Fort Collins, Colorado.

Described from three female specimens received from C. P. Gillette and said to be parasitic on *Macrosiphum frigida* Oest.

Trioxys aceris Haliday.

Aphidius (Trioxys) aceris Haliday, Ent. Mag. I, 1833, p. 490.

Female:—Length 2 mm. Black, smooth, shining. Head black, mouthparts pale yellow; antennæ 11-jointed, the scape, pedicel and first and second flagellar joints yellowish, remaining joints black; first joint of the flagellum longest, following joints approximately equal, the last joint twice as long as the preceding. Thorax entirely black and shining, the parapsidal furrows present only at the anterior angles of the mosonotum, the propodium with a distinct median transverse and median longitudinal carina and an indistinct enclosed area before the base of the petiole. Wings hyaline, veins and stigma very pale brown, the submedian cell faintly outlined, the second discoidal cell effaced or nearly so. Front legs including coxæ pale yellowish. Middle and posterior coxæ black basally, the apices yellowish; their trochanters, bases of the tibiæ and tarsi yellowish, femoræ and tibiæ reddish brown. Abdomen dark reddish brown, the petiole slightly lighter, smooth and shining; suture between first and second segments and apical segments beneath yellowish: ovipositor bent downward between the two horns at the apex of the abdomen and about as long as the horns.

Habitat:—Europe and College Park, Maryland.

Host:—*Chaitophorus aceris* Linn.

Redescribed from one specimen reared by the writer.

Trioxys ovalis Prov.

Neuropenes ovalis Prov., Add. Faun. Canad. Hym., 1886, p. 153.

Female:—Length 1 mm. Small species, head, thorax and abdomen piceus, not deep black. Head slightly wider than the thorax, brown-black; mouthparts including clypeus yellowish. Antennæ broken. The scape, pedicel and first flagellar joint yellowish; parapsidal furrows faintly impressed at anterior angles of the mesonotum; propodium distinctly areolated as in *rhagii*. Whole thorax brown black. Wings hyaline, stigma and all veins pale; second discoidal cell complete. All legs brownish yellow, the trochanters paler; the two posterior pairs of coxæ and the hind femoræ, tibiæ and tarsi somewhat darker than the rest. Abdomen but slightly longer than the head and thorax, brown-black except the extreme apex laterally, which is slightly yellowish; petiole with sides parallel, the spiracles not prominent. Ovipositor sheath bent downward between the anal processes.

Male:—Like the female but darker on the thorax and abdomen.

Habitat:—Canada.

Host:—Unknown.

Redescribed from one female type in U. S. National Museum and two male types in the Museum of Public Instruction, Quebec. Very much like *aceris* but much smaller.

SPECIES DESCRIBED AS *APHIDIINAE* WHICH ARE UNKNOWN TO THE WRITER.

The types of the following species not being available for study and the descriptions offering no characters upon which they could be definitely identified, they have not been included in the foregoing tables of species.

A specimen supposed to be the type of *Praon viburnaphis* is in the National Museum but as it does not fully agree with Fitch's description its identity is therefore doubtful. This specimen belongs in the genus *Lysiphlebus*.

Aphidius fuscoventris Cress., Proc. Ent. Soc. Phila., 1865, p. 89. (Cuba.)

Aphidius longicornis Cress., Proc. Ent. Soc. Phila., 1865, p. 90. (Cuba.)

Aphidius pallipes Cress., Proc. Ent. Soc. Phila., 1865, p. 90 (Cuba)

Aphidius fulvus Cress., Proc. Ent. Soc. Phila., 1865, p. 90. (Cuba.)

Aphidius delicatus Baker, Pom. Jour. Ent., I, 1909, p. 24 (Nevada.)

Aphidius coloratus Baker, Pom. Jour. Ent., I., 1909, p. 24. (Pennsylvania.)

Aphidius pulcher Baker, Pom. Jour. Ent.,- I, 1909, p. 24. (Nevada.)

Praon vibrunaphis Fitch, 1st and 2nd Rept., Ins. N. Y., 1856, p. 137. (New York.)

SPECIES DESCRIBED AS *APHIDIINAE* BUT BELONGING TO OTHER GROUPS.

Several species have been described as *Aphidiinae* which should have been placed elsewhere. The writer has in a previous paper [18] noted that the *Ephedrus completus* of Provancher (Add. Faun. Can. Hym., 1886, p. 156) really belonged in the *Braconid* group *Hormiinae* and that it is identical with Ashmead's species *Hormius erythrogaster* and antedates that species.

The species described by Fitch under the name of *Aphidius lactucaphis* (1st and 2nd Rept. Ins. N. Y., 1856, p. 136) is really a *Blacus* and, therefore, falls in the Ashmeadian group *Blacinae*.. Fitch's species *Toxares triticaphis* (6th Rept. Ins. N. Y., 1865, p. 840) is a *Dacnusinae* and seems to run to the genus *Grammospila* Foerst. The type of *Scotioncurus stenostigma* Prov., (Add. Faun. Can. Hym., 1886, p. 157) has not been examined but judged by the figure of the wing given by the author it is believed not to belong to this group.

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[18] Proc. Ent. Soc. Wash., Vol. XII, p. 189.

INDEX TO ABBREVIATIONS AND LIST OF PUBLICATIONS AND AUTHORS CONSULTED.

Add. Faun. Canad. Hym.=Additions et corrections au volume II de la Faune Entomologique du Canada, Quebec, 1886 and 1888.
Ann. Ent. Soc. Amer.=Annals of the Entomological Society of America. Vol. II.
Ashm.=Ashmead, (Dr. Wm. H.)
Baker=Baker, (C. F.)
Brullé.=Brulle, (A.)
Bull. Soc. Entom. Ital.=Bulletino de la Societá entomologica italiano. Firenzo, Italy. Vol. IX.
Bull. Univ. Kans.=Bulletin of the University of Kansas. Lawrence, Kansas. Vol. IX, No. 2.
Can. Ent.=The Canadian Entomologist. London, Ontario. Vols. XXII, XXIII and XXXIII.
Cat. Hymenop.=Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus. Auctore Dr. C. G. Dalle Torre, Professore Oenipontano. Leipzig. Vols. III and IV.
Colo. Biol. Assoc. Bull.=Colorado Biological Association. Bulletin No. 1, Washington, D. C.
Coquillet=Coquillet, (D. W.)
Cress=Cresson, (E. T.)
Curt.=Curtis, (J.)
Entom. Tidsk.=Entomologisk Tidskrift. Stockholm. 1910.
Ent. Mag.=The Entomological Magazine. London. 1833-1838.
Exp. Sta. Fla.=The Experiment Station of Florida at the State Agricultural College, Lake City, Fla. Bulletin No. 2. 1888.
Fitch=Fitch, (Dr. Asa.)
Foerst.=Foerster, (Dr. Arnold.)
Garm.=Garman, (H.)
Gen. Insect.=Genera Insectorum publies par P. Wytsman. Bruxelles, 1904. Fasicule 22.
Hal.=Haliday, (A. H.)
Hist. Natur. d. Ins.=Histoire Naturelle des Insectes, par M. le Comte Amédée Lepeletier de Saint-Fargeau. Paris, Vol. 4, 1846.
Holm.=Holmgren.
Hunter.=Hunter, (S. J.)
Intro. Mod. Class. Ins.=(See Westw.)
Ins. Life.=Insect Life. Devoted to the economy and life-habits of Insects, especially in their relation to Agriculture. Edited by C. V. Riley and L. O. Howard, Washington, D. C., Vols. III-VII.
MacIn. Bk. Gar.=MacIntosh's Book of the Garden. Vol. II.
Marsh.=Marshall, (Rev. T. A.)
Mich. Agri. Coll. Bull.=Michigan State Agricultural College, Zoological Department. Bulletin No. 73. 1891.
Natur. Canad.=Le Naturaliste Canadien. Bulletin de recherches, observations et decouvertes se rapportant a l'histoire naturelle du Canada. Quebec, Vol. XII, 1881.
Nees.=Nees von Esenbeck, (C. G.)

Nouv. Mem. Acad. Sc. Brux.=Nouveau Memoirs Academie des Science. Bruxelles. Vol. IX.
Nov. Act. Acad. L. C.=Nova Acta Academic Ceasaræ Leopoldino-Carolina Naturæ Curiosorum, 1818.
n. sp.=new species.
N. Y. State Mus. Bull.=New York State Museum, Bulletin No. 47, 1901.
Ofvers. Svensk. Vet. Akad. Forh.=Ofversight af Kongl. Vetenskaps-Akadamiens Forhandlingar. Stockholm, 1872.
Opusc. Entom.=Opuscula Entomologica. Lundæ. 1895.
Orange Insects.=Hubbard's Insects affecting the Orange, Washington, 1885.
Phillips=Phillips, (W. J.)
Pom. Jour. Ent.=Pomona Journal of Entomology, Pomona, California. Vol. I, 1910.
Proc. Ent. Soc. Phila.=Proceedings of the Entomological Society of Philadelphia. Vol. IV, 1865.
Proc. Ent. Soc. Wash.=Proceedings of the Entomological Society of Washington. Vols. IV, IX, X and XII.
Proc. U. S. Nat'l Mus.=Proceedings of the United States National Museum, Washington. Vols. XI and XXIII.
Proc. Wash. Acad. Sci.=Proceedings of the Washington Academy of Science. Vol. IX, 1902.
Prov.=Provancher, (Abbé Leon.)
Psyche.=Psyche. A Journal of Entomology Established in 1874. Boston. Vol. II.
Rept. Ill. St. Ent.=Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. 8th and 14th Reports.
Rept. Ins. N. Y.=Report on the Noxious and Beneficial Insects of the State of New York by Asa Fitch, M. D. 1st, 2nd and 6th Reports.
Rept. U. S. Com. Agri.=Report of the United States Commissioner of Agriculture. Washington, 1879.
Rohw.=Rohwer, (S. A.)
Roman.=Roman, (A.)
Rond.=Rondani, (Dr. C.)
Smith's Ins. N. J.=Insects of New Jersey. A list of the species occurring in New Jersey with notes on those of economic importance, by John B. Smith, Sc. D. Trenton, N. J., 1899.
Spec. d. Hym. d. Eur.=Species des Hymenouteres D'Europe and D'Algerie Par Ed. Andre. Vol. V, 1891.
Synop. Hymen. N. A.=A Synopsis of the Families and Genera of the Hymenoptera of America, North of Mexico, together with a catalogue of the described species and bibliography. Compiled by E. T. Cresson. 1887.
Syn.=Synonymy.
Szepligeti=Szepligeti, (Gy. V.)
Thomas=Thomas, (Dr. Cyrus.)
Thom. Opusc. Entom.=Thomson. Opuscula Entomologica Lundæ. 1895.

Trans. Amer. Ent. Soc.=Transactions of the American Entomological Society. Philadelphia, 1909.
Trans. Ent. Soc. London.=Transactions of the Entomological Society of London. 1885 and 1889.
Trans. Kans. Acad. Sci.=Transactions of the Kansas Academy of Science. Topeka, Kansas. Vols. XIX, XXIV.
U. S. Dept. Agri. Bu. Ent. Circ. Bul.=United States Department of Agriculture, Bureau of Entomology, Circular Bulletin. Nos. 85 and 93.
Verh. d. naturh. Ver. Preuss. Rheinl.=Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfallen. Vol. XIX.
Vier.=Viereck, (H. L.)
Webster=Webster, (F. M.)
Wesm.=Wesmæl, (C.)
Westw. Intro. Mod. Class. Ins.=Westwood, (J. O.) Introduction to the Modern Classification of Insects. Vol. II, 1840.
With.=Withington, (C. H.)

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN 153. MAY, 1911.

A STUDY SHOWING BACTERIA AND ANIMAL ORGANISMS DETERMINED IN THE FECES AND INTESTINAL MUCOSA OF HEALTHY CHICKENS.

By George Edward Gage.

Paper No. 2. From the Laboratory for the investigation of Poultry Diseases, Maryland Agricultural Experiment Station.

The comparative bacteriology and protozoology of the intestinal tract of man and animals have been subjects of considerable interest. Scientists, however, have paid but little attention to the organisms present in the intestinal contents and mucosa of healthy chickens. Several writers have published studies on the bacteriology of the domestic fowl which indicated clearly the scientific and practical importance of a thorough study of the bacteria of the intestinal and conjunctival membranes. These studies have been made on birds of about or the same age. In view of this fact the writer has undertaken to isolate and identify, as far as possible, the organisms, animal and plant, which were present in the intestinal contents and feces of chickens of different ages.

For many years it has been known that the alimentary canal during all periods of life of man and animal is the habitat for millions of microorganisms; it is likewise true that the biological characters of these microorganisms are not the same at all times of life. When the bacterial flora of apparently healthy persons and animals are compared, it has been found that the bacterial flora characteristic of different ages, present different biological characters and are responsible for different types of decomposition in the digestive tract.

The purpose of this paper shall be to set forth the methods used in making the examinations, together with the results obtained, wherever they may be of value as a contribution to the physiological and pathological bacteriology and protozoology of the intestines of healthy domestic fowls. By understanding more concerning the intestinal conditions in health, and some knowledge of organisms which may be present under such conditions, the avian pathologist may better know what to expect in disease. No attempt has been made to determine the cultivatable organisms numerically. Isolation and identification, as far as possible, have been the points principally considered. By careful routine work the data has been made relatively conclusive in regard to the specific organisms present.

Source of Material for Study.

The observations were made upon the feces of forty-five birds ranging in age from one day old up to two years, and upon the intestinal mucosa of sixty birds, including birds taken from the shell, newly hatched chicks, and fowl ranging in age up to two years. Observations were made three times on each of the 45 birds used for study of the morphologically different bacteria in the feces. By using birds of sufficiently different ages it was possible with the forty-five birds to get material representative of the different periods of a bird's life, and obtain feces from the several ages in sufficient quantities to make the bacterial and protozoological examinations.

The young chicks from one day to six weeks of age were fed for the first four days on boiled egg ground up with bread crumbs, then on commercial chick feed, containing cracked corn, wheat, hulled oats, rice, Canadian peas and some millet. Besides this, they probably picked up the worms and bugs which happened to be about in the yards. The chickens five weeks to 12 and 15 weeks of age were fed almost exclusively on wheat, being allowed to pick grass and insects about the poultry yard. The birds over one year old were fed a grain mixture of cracked corn, wheat and oats, and a mash mixture of bran, linseed meal, corn meal, middlings, beef scrap, charcoal and salt. In the morning these hens received the grain mixture, followed in a few hours by cabbage, and at noon a grain mixture was fed again. The dry mash mixture, grit and oyster shell were kept in hoppers, to which the fowls had free access at all times. These dietaries represented ordinary mixed diets. All of them may be regarded as normal and the bacteriological and protozoological examinations considered as representative of the intestinal conditions of healthy chickens.

COLLECTION OF MATERIAL.

1—Material for Examination of Feces.

The birds were brought from experimental pens directly to the laboratory and the feet and legs and a portion about the anus thoroughly washed with mercuric chloride solution (1-1000) and with 95 per cent. alcohol. They were placed in a sterile cage upon a sterile glass plate. The cages were especially constructed to allow of sterilization. They were collapsible and were sterilized in an autoclav at 110 degrees C. with pressure of 25 atmospheres for two hours. Careful vigilance was kept, and as soon as the feces were passed, they were immediately picked up by means of a sterile section lifter and introduced into 10 c. c. of sterile physiological saline solution, which was retained in a test tube of large calibre. The whole was then violently shaken for five minutes to break up microscopic bacterial clumps. After addition of 15 c. c. more of a sterile physiological-saline solution, and after another vigorous shaking, the suspension was ready to prepare smears for making the differential count.

2—MATERIAL FOR ANIMAL ORGANISMS.

The examination for animal organisms was made directly from a portion of the fecal suspension diluted slightly with physiological saline and from the suspension prepared for the differential count.

3—MATERIAL FOR EXAMINATION OF INTESTINAL MUCOSA.

The chicks removed from the shell just prior to hatching were placed on a sterile piece of cheese cloth and rubbed over with alcohol. They were immediately killed, opened, and the intestines laid on the cloth and opened carefully with a sterile pair of fine scissors. Plates were made from scrapings from the mucosa of the duodenum, ileum, caeca and cloaca. The material obtained from older birds was removed with the same precautions. Histological sections were made in some cases.

4—MATERIAL FOR EXAMINATION OF ANIMAL ORGANISMS IN INTESTINAL MUCOSA.

Part of the material from the mucosal scrapings was placed in a test tube containing 10 c. c. of sterile bouillon and examined directly in fresh preparation.

TECHNIQUE FOR MAKING DIFFERENTIAL COUNTS OF BACTERIA.

For the estimation of the numbers of morphologically different bacteria of the feces, the methods used for the study of human feces by MacNeal, Latzer and Kerr (1909) were employed.

Having prepared bacterial suspensions according to previous directions the following steps as outlined by the above authors were followed:

A thin even cover glass preparation was prepared, dried and fixed in the flame, and floated with anilin gentian violet and allowed to remain three minutes. This was drained off and replaced by Lugol's solution, being allowed to remain two minutes. This was drained off, and the slide dried between filter paper. It was decolorized in anilin xyol by immersion for one-half minute and further decolorized in alcohol for from five to ten seconds. It was then washed in water and counterstained in safranin, washed again, dried and mounted.*

1909, MacNeal, Latzer and Kerr, Fecal Bacteria of Healthy Men. Jour. Inf. Diseases, 1909 Vol. 6, No. 2, pp. 123-169.

*Note.—Safranin was used instead of fuchsin as designated by MacNeal, Latzer and Kerr. Some of the preparations were made directly on the slide and examined directly with oil immersion without cover glass mount.

In most of the stained preparations five hundred bacteria were counted, in some three hundred. The greatest difficulty experienced was the preparation of slides, in which there was even distribution of fecal material. This is quite necessary if differentiation is to be made between small rod-shaped bacteria and small bits of organic matter such as cellulose fibres, etc. The greatest source of error was the staining reaction of some of these small bits of foreign material. They appeared in a few slides stained as gram negative organisms. The same difficulties were experienced with the bird feces as was experienced in the study of human feces. In a few slides it was hard to differentiate gram negative and positive organisms. As a whole the examination afforded interesting microscopic pictures and bacteriologically appeared to be of value in demonstrating intestinal conditions in the alimentary tract of the domestic fowl.

Method of Procedure with Cultural Studies.

After having removed sufficient quantities of a fecal suspension for determining the morphologically different bacteria of the feces, two sets of plates were poured, using agar-agar and gelatine. Three fermentation tubes containing glucose bouillion were inoculated from the same suspension. At the end of 72 hours colonies were noted, and each different colony inoculated on to argar slant, incubated until growth had taken place, when it was numbered to await biochemical and differential tests. Anaerobic tubes were prepared from the original fecal suspension. Bouillon was used and anaerobiosis established by Wright's method.*

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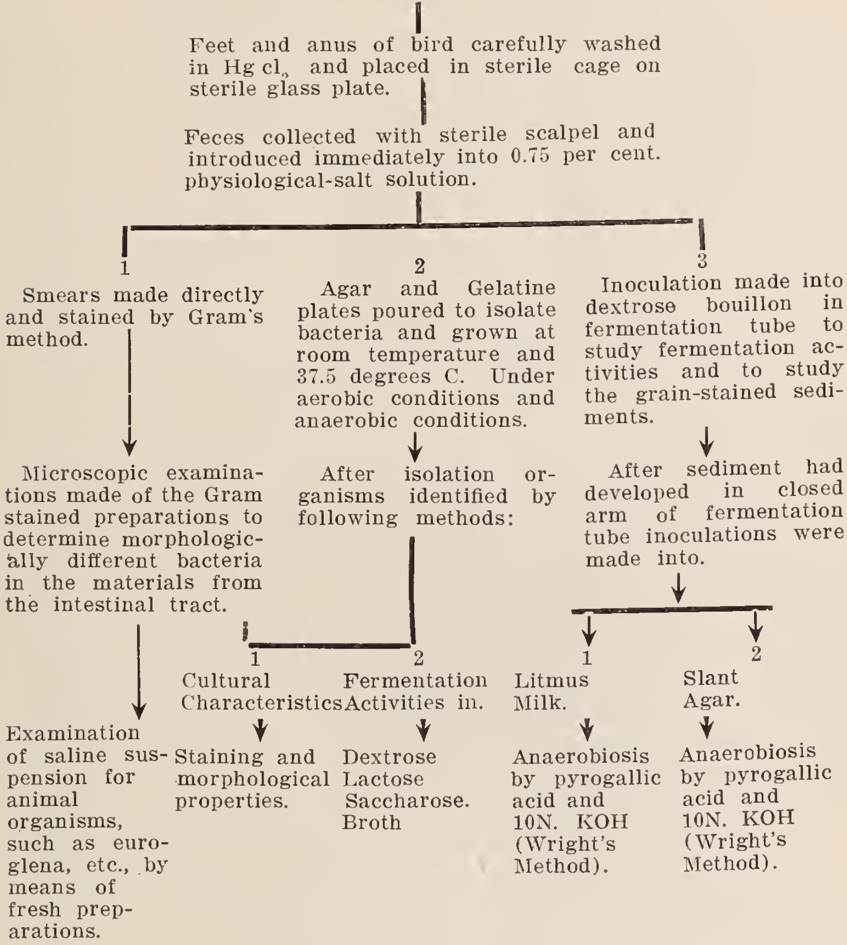
*Pathological Technique, Mallory and Wright, page 126.

METHODS OF PROCEDURE TO DETERMINE BACTERIA PRESENT IN THE FECES OF HEALTHY CHICKENS.



Feet and anus of bird carefully washed in Hg cl_2 and placed in sterile cage on sterile glass plate.

Feces collected with sterile scalpel and introduced immediately into 0.75 per cent. physiological-salt solution.

1

Smears made directly and stained by Gram's method.

Microscopic examinations made of the Gram stained preparations to determine morphologically different bacteria in the materials from the intestinal tract.

Examination of saline suspension for animal organisms, such as euroglena, etc., by means of fresh preparations.

2

Agar and Gelatine plates poured to isolate bacteria and grown at room temperature and 37.5 degrees C. Under aerobic conditions and anaerobic conditions.

After isolation organisms identified by following methods:

1

Cultural Characteristics

Staining and morphological properties.

2

Fermentation Activities in.

Dextrose
Lactose
Saccharose.
Broth

3

Inoculation made into dextrose bouillon in fermentation tube to study fermentation activities and to study the grain-stained sediments.

After sediment had developed in closed arm of fermentation tube inoculations were made into.

1

Litmus Milk.

Anaerobiosis by pyrogallic acid and 10N. KOH (Wright's Method).

2

Slant Agar.

Anaerobiosis by pyrogallic acid and 10N. KOH (Wright's Method).

Inoculations were made from each organism into lactose-neutral red broth, dextrose and saccharose bouillon, in fermentation tubes, litmus milk, gelatine and nitrate broth, and the morphological and staining properties noted by use of the Gram's method. The sediments from the dextrose fermentation tubes were stained by gram and material from such sediments inoculated into litmus milk and grown under anaerobic conditions.*

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*Method Suggested by Herter, Bacterial Infections of the Digestive Tract.

HISTORICAL.

Kern (1897) has shown that the stomach and intestines of birds in general proved to be an extraordinary rich source of micro-organisms. In twenty-four birds investigated by him eighty-eight species of bacteria were detected. Direct microscopic preparations of the stomach and intestinal contents led him to suppose that a large number of species do not grow when submitted to ordinary methods of cultivation. The motile bacilli and pseudomonades were represented with 32 species, the micrococci with 28, the bacteria by 20 species, and the sarcinae by eight species. A common characteristic of the bacteria isolated was their ability to liquify gelatine. A relatively large number of the rod forms reproduce by spores. Only a few species produced color and these were principally the micrococci, which occur in granivorous birds. B. coli was the most abundant, being found in 15 birds, twenty-four times, and it occurred in nine birds in the stomach as well as in the stomach contents. *Micrococcus nitidis* was found in nine birds. *Bacillus vegatus* was detected in eight, *B. defessus* in five, *B. vergatus* in six, *Bacterium verruscosum B. cavatum* and *Pseudomonas granulata* in four subjects. He found twenty-one species in the avian intestine, the colon bacillus being predominant.

King (1905) found that the flora of the intestinal mucosa is to a certain extent constant. This flora appeared to depend upon the environment, and varies within certain limits, according to external conditions. The mucosa of the caecum and colon were inhabited by a larger number of species than any other portion of the intestinal canal. The average number of colonies showing on plates made from different levels of the intestines show a gradual decrease in number the closer the examinations are made to the stomach, i. e., in the ileum, jejunum and duodenum. *Bacillus coli* is the predominating organism, and it is almost always found in the caeca and colon, frequently found in the lower portion of the small intestine and rarely found in the duodenum.

Pernòt (1908) has reported a complete study of eggs, and has examined eggs from the size of a pea to the perfect egg, finding organisms at every stage. He also studied the permeability of the shell to micro-organisms, and finds that it is not bacteria tight. The common species which may be present in the healthy hen's egg he reports to be *B. subtilis, B. mycoides* and *B. mesentaricus fuscus*.

Pennington (1910) showed that organisms are usually to be found

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1897, Kern, Heinrich, Beitrag zur Kenntniss der in Darme und Magen der Vogel vorkommenden Bakterien—Arbeiten aus dem Bakteriologischen Institut der Technischen Hochschule zu Karlsruhe 1897, Vol. 1, pp. 377-532.

1905, King. The Bacterial Flora of the Intestinal Mucosa and Conjunctiva of the Normal Chicken. Journal American Medicine, Vol. 10 (1905), p. 400.

1908, Pernot, E. F. An Investigation of the Mortality of Chicks. Oregon Experiment Station Bulletin No. 103.

1910, Pennington, Dr. Mary, A Chemical and Bacteriological Study of Fresh Eggs. Jour. Biol. Chem. Vol. VII, No. 2, pp. 109-132.

in both yolk and white. In 57 experiments 18 had a greater number in the yolk; 11 had the majority in the white and 21 had an almost even distribution; 7 were sterile. Thirty-six species of bacteria were found in the 100 eggs from which the varieties were isolated. The only organisms which grew on Wright's anaerobic plates were *Micrococcus aurantiacus, B. fluorescens* (Frankland) and *B. aurantiacus, Micrococcus viticulosis,* Fluggei, *M. versicolor,* and two coral yeasts.

The tables which follow show the organisms isolated from the mucosa of different levels of the intestinal tract. A cross (X) indicates that the organism noted was isolated several times; thus substantiating quite conclusively its presence. These may only represent the organisms which will grow according to our cultural methods. The fact is that many of the organisms which might be cultivated may be shown to be no longer living, but to be undergoing a particular process of disintegration, probably due to bacterial antagonism or dissolution in their own juices, i. e., a process of antolysis. For this reason in some preparations it was difficult to count the morphologically different bacteria.

The bacterial and animal organic conditions during early life of a chick are considerably different from those of later life. Of course any of the organisms found during this period are likely to be found later, since the environmental conditions are liable to be the same, based on the fact that many articles of diet are continued as a mixed ration in later life. When a bird becomes fully grown factors usually enter in, which tend to influence the bacterial and animal organic conditions. The habits of birds in any particular flock are much the same, therefore, there might not be as great a variance in the intestinal conditions as in man.

In considering the mucosa as regards bacteria and animal habitation, it has been said that the epitheleal cells along the tract in man have to do with the protection of the body from invasion by bacteria within the tract. There exists, in regard to human bacteriology some experimental evidence that a fully developed layer of epithelium is an important barrier to the entry of at least some kinds of bacteria. According to Hilgermann (1905) it appears that the normal mucous membrane is more permeable to some bacteria during infancy than during later life, due to the fact that the mucous membrane in early life is lacking in natural protective substances capable of hindering the penetration of bacteria or other organic bodies. This appears to be an interesting consideration in regard to young chicks only a few days old. Although the specifically different bacteria are few the plates invariably show them present in rather large numbers. This has been noticed on several occasions in young chicks examined from time to time which were not on this experiment.

Ficker (1905) considered that a combination of fasting and fatigue

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1905. Hilgermann. Die Bakteriendurchlassigkeit der normalin Magendarmschleumhaut un Saulingsalter, Archiv fur Hygiene LIV p. 335.

1905. Ficker, Ueber den Einfluss der Hungers auf die Bakteriendurchlassigkeit des Intestinaltraktus. Arch, fur Hygiene LIV p. 354.

facilitated in an extraordinary way the passage of germs through the intestinal tract. Under the influence of powerful bodily action the volume of gastric juice and other digestive fluids is greatly reduced, peristalsis is diminished, while on the other hand, the lymph and blood flow are actively accelerated, all being factors which might favor penetration of bacteria. Increased leucocytosis induced by extremely active muscular exertion is responsible for the increased extravascular bactericidal power of the serum which he observed, and thus that the leucocytes may be regarded as carriers of bacteria from the intestinal tract. After having worked with the 60 birds and noted the comparatively small number of bacteria in the mucosa, it cannot be said that any of these factors may be at work aiding in the penetration of intestinal bacteria through the avian intestinal wall. The blood in the healthy active chicken appears free from the organisms, and even in some diseases it is quite difficult to determine the micro-organisms in the blood stream.

Consideration of Bacteria in the Mucosa of Birds of Different Ages.

Duodenum.—After consideration of the data at hand it appears that the greatest number of cultivatable bacteria are present in the duodenum. B. subtilis was found 31 times, being present in the duodenum of every chick removed from the shell. Two of the one-day-old chicks harbored it in duodenal mucosa, three of the three-day-old chicks, two of those six days old, two of those two weeks and representatives of the other age classes harbored it, as will be seen from the table. *B. subtilis var. viscosis* was found only in two birds, subject 303 and 302, which belonged to the 12 to 15 week class. *B. mesentaricus* can often be isolated from the duodenal mucosa of healthy birds. *B. ramosus* is a common inhabitant of this mucosal lining. *B. cereus* may be considered an organism which can be isolated under ordinary conditions in health. *B. asterosporus* was isolated but twice during this study with 60 birds. It is not to be expected that this organism would occur often in the mucosa of chicken since it is difficult to isolate it from grains and grasses and soil under the best of conditions. *B. ruminatus* (Gottheil), *B. fusiformis* (Meyer and Gottheil) occur rarely in the duodenal mucosa. *B. megatherium* may be considered a common invader of the mucosa of the duodenum. *B. fluorescens liquifaciens* and *non-liquifaciens* occur only rarely, but *B. coli* is the most common of all of organisms isolated. *B. acidi lactici* and *B. lactis acrogenes* are frequently found, while *B. prodigiosis* appeared but twice during the study of the 60 subjects. *Sarcina aurantiaca* and *lutea,* although present in the intestinal contents, rarely occurred in the mucosa of the duodenum. The staphylococci occurred often in the intestinal contents, but to cultivate them from the healthy duodenal mucosa was successful in but nine cases, the specific organisms being *Staphylococcus pyogenes albus*, *Staphylococcus cereus albus*, *Staphloccoccus pyogenes citreus* and *Staphylococcus cereus flavus* respectively. *Clamydothrix ferruginea* (Ehrenberg), *Micrococcus roseus,* white and coral yeasts, brown, white and green moulds, *Micrococcus rosettaceus* and *Cladothrix asteroides* make up the remaining bacteria and moulds, the distribution of which may be noted from the table.

Ileum.—From the ileum mucosa *B. subtilis* was isolated and cultivated from thirty subjects, *B. megatherium* from sixteen, *B. fusiformis* (Gottheil) from five, *B. cereus* from eleven, *B. mesentaricus* from four, *B. Prodigiosis* from two, *B. coli* from thirty-six, *B. lactis aerogenes* from four, *B. fluorescens liquifaciens* from one, *Styaphylococcus pyogenes albus* from one. *Staphylococcus pyogenes citreus* from two, *Staphylococcus cereus albus* from six, *Sarcina aurantiaca* from four, *Sarcina lutea* from one, *B. ramosis* from five, *B. cloaca* (Jordan) from *one, cladothrix asteroides* from three and green and white moulds from two.

Caeca.—From the caecal mucosa of the young birds taken from the shell were isolated, but two different organisms, namely, *B. subtilis* in four subjects and *B. megatherium* in one, *B. mesentaricus* was isolated and cultivated from the caecal mucosa in eight subjects of birds from one day to two years old, *B. subtilis* from nineteen, *B. megatherium* from eighteen, *B. cereus* from twelve, *B. fusiformis* from one, *B. coli* from forty-five, *B. asterosporus* from four, *B. acidi lactici* from four, *B. lactis aerogenes* from four, *B. fluorescens liq.* from five *Staphylococcus pyogenes albus* from six, *Staphylococcus cereus albus* from six, *Cladothrix asteroides* from four, yeasts from two, Green moulds from one, *Clamydothrix ferruginea* from one, *B. aerogenes capsulatus* from one and *B. ramosus* from one.

Cloaca—B. subtilis was cultivated from the mucosa of the cloaca in twenty subjects. *B. megatherium* and *B. cereus* appear to be common in the intestinal tract of chicks before hatching. From the duodenal mucosa was cultivated *B. subtilis, B. mesentaricus* and *B. ramosus* and the new forms cultivated from the cloaca of chicks taken from the shell were *B. megatherium* and *B. cereus. B. mesentaricus* was isolated from the mucosa of the cloaca in seven of the sixty subjects, *B. fusiformis* (Gottheil) in one, *B. asterosporus* in nine, *B. fluorescens* in five, *B. acidi lactici* in three, *B. lactis aerogenes* in five, *B prodigiosis* in three, *Clamydothrix ferruginea* in six, *Cladothrix asteroides* in eight, *Staphylococcus cereus albus* in one, *Staphylococcus pyogenes aureus* in three, *B. cloacae* in three, *M. roseus* in one, yeasts in six, green and white moulds in three, and in the cloacal mucosa of 42 was isolated *B. coli, Sarcina aurantiaca* was cultivated from the cloacal mucosa in five and *B. aerogenes capsulatus* in one subject.

DISCUSSION OF THE BACTERIOLOGICAL FINDINGS IN THE INTESTINAL MUCOSA.

This study apparently shows that the intestinal mucosal bacteriology of the domestic fowl is practically aerobic. The presence of large amounts of gas in the caeca in health has suggested the presence of such organisms as the Welch bacillus. Considerable time has been devoted to the search for obligatory anaerobes which might explain the intestinal gas production in health, but in only three cases were

Organisms isolated from the mucosa of the Duodenum of Birds of diffrent ages

Name of Organism	Birds taken from Shell												Birds 1 Day old				Birds 3 Days old				Birds 6 Days Old				Birds 2 weeks Old.					Birds 5 weeks old						Birds 10 weeks Old.				Birds 12-15 weeks old.						Birds 1-2 years old.									Birds 2 years old.					
No. of Bird →	1	2	3	4	5	6	7	8	9	10	11	12	80	81	77	70	73	74	78	76	79	76	72	75	13	14	15	16	17	18	19	20	21	22	23	305	304	310	311	300	303	302	305	307	306	49	56	75	51	71	62	65	73	59	12	13	90	91	92	93
Bacillus subtilis	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X			X	X		X				X				X		X	X					X				X			X			X				X		X		X	
Bacillus subtilis var. viscosus																																									X	X																		
B mesentaricus						X					X				X													X					X																					X			X		X	
B ramosus	X		X	X			X		X		X	X										X	X												X			X		X	X																		
B. cereus													X						X		X				X				X					X										X	X														
B. asterosporus																																				X																X						
B ruminatus (Gottheil)																																										X	X																	
B fusiformis (Myer & Gottheil)																																												X															
B. megatherium (De Bary)																	X		X				X		X	X	X	X	X							X				X			X		X	X	X	X	X	X	X						X			X
B. fluorescens liq.																																						X									X				X									
B. fluorescens non liq.																																						X										X									X			
B. coli communis														X	X	X		X				X		X	X	X	X			X		X					X		X					X				X	X	X		X		X	X					
B acidi lactici																									X	X																							X			X		X						
B lactis aerogenes																																																X	X	X		X	X							
B. prodigiosus																																										X															X			
Sarcina aurantiaca																	X		X									X																											X					
Sarcina lutea																	X																																											
Sarcina ventriculus																	X																																											
Staphylococcus pyogenes albus (Rosenbach)																			X								X																				X													
S. pyogenes citreus																																			X																									
S. cereus albus																			X																																									
S. cereus flavus													X							X	X													X																										
Clamydothrix ferruginea ([illegible])																																																						X	X	X	X			
Micrococcus roseus													X								X									X																									X			X		X
Yeasts (coral)																																																							X					X
Yeasts (white)																																																										X		
Moulds (Brown)												X									X									X					X				X								X		X							X				X
Moulds (White)																																			X																									
Moulds (Green)																		X						X			X						X				X								X							X						X		
M. rosettaceus																					X										X												X													X				
Cladothrix asteroides																																																					X							

Organisms isolated from mucosa of the Ileum of Birds of different Ages.

	Birds taken from shell												Birds 1 Day old				Birds 3 days old				Birds 6 Days old				Birds 2 weeks old					Birds 5 weeks old						Birds 10 weeks old				Birds 12-15 weeks old						Birds 1-2 years old									Birds 2 years old					
	1	2	3	4	5	6	7	8	9	10	11	12	80	81	77	70	73	74	78	76	79	76	72	75	13	14	15	16	17	18	19	20	21	22	23	308	309	310	311	300	303	302	305	307	308	69	56	75	51	74	62	65	73	59	112	143	90	91	92	93
B. subtilis			X		X		X	X		X		X	X		X		X	X		X	X		X	X	X	X	X				X	X	X	X										X	X		X	X	X	X	X			X	X					
B. megatherium				X		X			X							X	X											X				X			X	X							X	X	X				X	X	X		X							
B. fusiformis (Meyer & Gottheil)																									X											X							X		X			X												
B. cereus							X								X		X								X	X							X						X					X				X		X	X									
B. mesentaricus																								X															X														X	X						
B. prodigiosis																																																								X	X			
B. coli													X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X			X		X			X		X	X	X		X	X	X	X		X	X	X	X	X	X	X
B. lactis aerogenes																										X																		X	X							X								
B. lactici acidi													X																X					X																					X					
B. asterosporus																		X																																										
B. fluorescens liq.																								X																																				
Staphylo. pyogenes y. albus																																										X																		
Staphylo. pyogenes citreus															X																	X																												
Staphylo cereus albus																					X	X	X										X	X																			X							
Sarcina aurantiaca																				X											X				X																				X					
Sarcina lutea.																																																							X					
B. ramosus			X				X				X																														X				X															
B. Cloacae (Jordan)																																			X																									
Cladothrix asteroides																							X																X														X							
Moulds (Green)																																																							X					
Moulds (White)																																																							X					

Organisms isolated from the Mucosa of the Caecum of Birds of different Ages.*

Name of Organism	Birds taken from Shell												Birds 1 Day old				Birds 3 Days old				Birds 6 Days old.				Birds 2 weeks old					Birds 5 weeks old.						Birds 10 weeks old				Birds 12–15 weeks old						Birds 1–2 years old									Birds 2 years old.					
No. of bird →	1	2	3	4	5	6	7	8	9	10	11	12	80	81	77	76	73	74	78	76	79	76	72	75	13	14	15	16	17	18	19	20	21	22	23	308	309	310	311	300	303	302	305	307	306	69	56	75	57	74	62	65	73	59	42	43	90	91	92	93
B. mesentericus (Flügge)														X				X										X		X									X	X													X	X						
B. subtilis			X		X	X		X							X				X		X			X		X			X				X	X			X	X	X		X				X			X			X					X	X	X	X	
B. megatherium							X									X	X			X		X	X		X	X		X				X			X			X			X			X				X	X			X	X					X		
B. cereus															X						X			X	X	X							X	X							X							X	X	X	X									
B. fusiformis																																																		X										
B. coli													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
B. astrosporus														X				X												X																						X								
B. acidi lactici																	X								X												X													X									
B. lactis aerogenes																						X			X													X							X															
B. fluorescens liq.									X							X				X												X			X																									
Staphylo. pyo. f. albus																																X		X		X						X	X													X				
Staphylo. cereus albus													X			X			X		X								X					X																										
Cladothrix asteroides																																										X											X				X		X	
Yeast																		X												X																													
Mould (Green)																																																										X		
C. ferruginea																																												X																
B. aerogenes capsulatus																																																						X						
B. ramosus (mycoides)																																																						X						

Organisms isolated from mucosa of the Cloaca of Birds of Different Ages.

Name of Organism	Birds taken from Shell												Birds 1 Day old				Birds 3 Days old				Birds 2 weeks old				Birds 5 weeks old				
No of Bird →	1	2	3	4	5	6	7	8	9	10	11	12	80	81	77	70	73	74	78	76	79	76	72	75	13	14	15	16	17
B. megatherium	X			X		X	X		X		X										X				X				X
B. ramosus		X	X	X			X					X	X																
B. cereus					X		X	X													X								X
B. subtilis		X		X		X			X		X			X							X		X		X				X
B. mesentaricus																			X						X				
B. fusiformis (Gottheil)																													
B. asterosporus														X				X		X							X		X
B. fluorescens																								X				X	
B. fluorescens liq																													
B. lactici acidi																													
B. lactis aerogenes																X								X					
B. prodigiosis																								X					
Clamydothrix ferrugineus															X					X								X	
Cladothrix asteroides																							X	X					
Staphylococcus cereus albus																													
B. cloacal																													
B. roseus																								X					
yeasts																				X									
moulds (Green)																													
moulds (White)																													
B. coli													X	X	X	X		X	X	X	X	X		X	X	X	X	X	X
Staphylococcus pyogenes aureus																							X						
Sarcina aurantiaca																							X						
B. aerogenes capsulatus																													

Name of Organism	Birds 10 weeks old						Birds 10 mths old				Birds 12-15 mths old						Birds 1 – 2 years old									Birds 2 years old					
No of Bird →	18	19	20	21	22	23	308	309	310	311	300	303	302	305	307	306	69	56	75	51	74	62	65	73	59	112	113	90	91	92	93
B. megatherium									X		X		X		X				X		X						X				
B. ramosus						X		X						X											X		X		X	X	
B. cereus									X				X		X						X	X									
B. subtilis	X				X	X									X				X		X	X	X					X			X
B. mesentaricus				X						X															X	X				X	
B. fusiformis (Gottheil)																														X	
B. asterosporus	X																	X								X		X			
B. fluorescens											X											X									X
B. fluorescens liq																								X				X			
B. lactici acidi														X														X		X	
B. lactis aerogenes			X												X					X											
B. prodigiosis				X						X																					
Clamydothrix ferrugineus							X										X											X			
Cladothrix asteroides									X						X									X			X		X	X	
Staphylococcus cereus albus																							X								
B. cloacal																								X				X	X		
B. roseus																															
yeasts	X	X																								X	X	X			
moulds (Green)								X																				X			
moulds (White)																														X	
B. coli	X	X	X	X	X	X	X			X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staphylococcus pyogenes aureus							X																					X			
Sarcina aurantiaca						X																					X		X		X
B. aerogenes capsulatus																					X										

they isolated from the intestinal mucosa; namely, B. putrificus in subject 81 from the feces and B. aerogenes capsulatus in subject 59 from the caecal mucosa, and in subject 74 from the cloacal mucosa. Although more than one hundred tubes were inoculated with materials from sediments from dextrose fermentation tubes inoculated with mixed fecal flora and with the scrappings of the mucosa of the duodenum, ileum, caeca and cloaca of birds of different ages only a few exhibited reactions which were typical for the anaerobic gas-forming bacillus. Material from sediments of fermentation tubes mentioned above were grown under complete anaerobiosis, and then inoculated intravenously into a rabbit according to the Nuttall-Welch test. The only two which gave the test for the anaerobic gas-bacillus, when submitted to the milk test according to Buchner's method were those just noted.

The rare occurrence of them in the intestinal contents and mucosa of healthy chickens would suggest that the habit of living upon a diet almost exclusively of grains and herbivorous materials would necessitate differences in the types of bacteria which characterize the intestines of avian life. Experiments have been conducted which quite clearly distinguish between the type of bacterial flora in herbivorous and carnivorous animals. It has been noted in the dog, which is generally considered carnivorous, that the intestinal contents often showed the presence of large numbers of spores, spore-bearing bacilli and vegetative forms of anaerobes. Saiki and Wolbach (1909) have also demonstrated large spore-bearing anaerobes in the liver of dogs.

In a recent study, Dr. F. De Gasperi (1911) has demonstrated the difference in the intestinal bacterial flora of white rats when fed on the ordinary diet and when fed exclusively on meat. On a meat diet obligatory anaerobes were very much in evidence, while on an ordinary diet anaerobic flora predominated. A study of a grown cat fed upon raw meat showed the presence of gram positive vegetative anaerobes from one end of the digestive tract to the other. Observations made on the wolf, tiger and lion, and the fecal examination revealed the presence of considerable numbers of gram positive bacilli suggesting B. aerogenes capsulatus.

It was found that bouillon cultures of the mixed fecal flora from the lion, tiger, wolf and cat all developed quickly a sufficient amount of methyl mercaptan to give a prompt, strong reaction with isatin and sulphuric acid.

When observations were contrasted with those made upon herbivorous animals, including the buffalo, goat, horse, elephant and camel, which may in a way be considered as being nourished on material which simulates an avian dietary, the bacteriological pictures are quite different. In the case of the camel, elephant and horse the preponderant bacteria in the gram-stained fields were small, gram-negative or-

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1909, Saiki and Wolbach, Jour. Med. Research, Vol. XXI, 1909, p. 267.

1911, Dr. F. De Gasperi, "Flore intestinale des rats blancs au régime ordinaire et au régime carné," Centralblatt fur Bakteriologie etc., Originale Heft. 6, Band. 57, p. 519.

ganisms which were regarded as special forms of Bacillus Coli. In the case of the goat the field contained some gram positive bacteria, and of the gram-negative ones a considerable number were of a greater length than the dominant small forms which were regarded as belonging in the class of colon bacilli. The mixed flora of these different herbivorous animals grown in peptone bouillon, failed to show the production of methyl mercaptan, except in the case of the horse, where a moderate reaction was obtained. The avian fecal flora is remarkably gram-negative under healthy conditions.

It is interesting to note that in the case of the young chick taken from the shell that the colon bacillus was absent in every case, and such has been the result from several examinations made since the twelve recorded. Pernot examined eggs from the size of a pea to the perfect egg, finding organisms of the subtilis group, but B. coli was not present.

From the table it may be seen that B. coli was present in the intestinal mucosa of many of the cases and undoubtedly it plays the same role physiologically that it does in the alimentary canal of higher animals. Since it is so persistently present it is undoubtedly an obligate bacteria, which has adapted itself to the secretions of this part of the body and under the ordinary conditions holds its own against newcomers. In the domestic fowl from all appearances they are capable under some circumstances of doing a service by giving rise to conditions which discourage the growth of many harmless and harmful species which the bird cannot exclude readily. The suggestions of Dr. Herter (1908) may well be applied to the avian intestinal tract.

He believed that the chief significance of the obligatory intestinal bacteria lay in their potential capacity for checking the development of other types of organisms capable of doing injury.

The evidence now available suggests that in health the colon bacillus both in man and the higher mammals exert an important function in combatting the development of the injurious saprophytes and which even in ordinary health the human intestinal tract almost necessarily abounds. When the colon bacilli are able to grow freely, they can act protectively to the digestive tract. If the conditions are such in the intestines that they cannot multiply abundantly they can neither exhaust the nutritive material on which other races grow nor make products endowed with inhibitory powers. If this be true it appears that in the avian intestines the Colon bacillus must have an important part in the protection of the body of the bird from invading harmful

Consideration of Bacteria Isolated from Feces of Healthy Birds.

The bacterial flora of the feces of the healthy fowl depend upon the environment, and varies within certain limits. From the study of the feces, it has been possible to determine considerable concerning the usual inhabitants of the tract. B. coli was identified in nearly every

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1908, "Bacterial Infections of the Digestive Tract," page 5.

Table showing the organisms isolated from the feces of Birds of different Ages—

Name of Organism	Birds 1 Day old				Birds 3 Days old			Birds 6 days old				Birds 3 to 5 weeks old —												Birds 12 to 15 weeks old									Birds 1 to 2 years old.												
	80	81	77	70	73	74	78	79	73	72	75	63	67	70	65	64	61	62	66	60	68	69	70	300	302	303	305	306	307	308	310	311	69	77	56	75	51	52	74	62	65	73	66	78	59
B. mesentaricus				X				X				X					X							X									X			X			X	X					X
B mycoides		X	X			X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
B. ruminatus															X											X																			
B fusiformis								X																									X												
B asterosporus																															X														
B fluorescens liq.												X																																	
B fluorescens non liq												X																																	
B coli					X		X	X			X				X	X		X	X	X	X	X		X		X			X		X	X	X	X	X	X			X	X	X	X	X	X	X
B. cereus	X				X			X				X				X			X			X								X						X									
B megatherium		X		X	X																X	X				X								X											
B subtilis			X	X		X		X		X		X				X			X				X		X			X			X			X	X	X	X	X	X	X	X	X	X	X	X
B. prodigiosus				X												X												X				X							X						
B putrificus		X																																											
B. lactis acidi																						X	X																						
Sarcina aurantiaca	X					X	X										X										X				X	X		X		X		X		X		X			
Sarcina lutea	X												X		X				X																										
Staph. cereus flavus	X	X			X	X		X		X	X							X	X				X				X		X			X					X		X	X			X		
Staph. pyogenes citreus									X					X			X		X			X			X								X												
Micrococcus roseus	X			X																																									
Streptothrix ochracea								X	X																					X									X					X	
Clamydothrix ferruginea																																						X							
Cladothrix asteroides											X								X		X	X			X				X														X		
B enteritidis																																										X			
Staphococcus pyogenes albus													X		X		X					X					X										X								
B. cloacae (Jordan)											X																								X					X					

sample, and it is very interesting to note that there is always possibility organisms. of the organism in the intestinal contents being absorbed into the mucosa. This would appear to indicate that the protective substance in the case of birds allows bacteria to penetrate more freely into the mucosa than in the case of man and animals. Several writers have established several micrococci isolated from the intestinal contents (feces) and the intestinal mucosa and have designated them as Micrococcus, A, B, etc. When the work was first started it was thought that the micrococci were represented by a great number of species. As the work progressed it was possible to place these micrococci in their particular class. After several times considering each it was found that those which had been unclassified on account of conflicting characteristics were finally identified as a staphylococcus or a sarcinae. The handling of so many cultures and keeping data on so many might lead one to assume that unless an organism exhibited some signs within a reasonable length of time that it best be classified as an unknown micrococcus. The facts of the case are established as far as this work is concerned that practically all the micrococci present in the intestinal mucosa and intestinal contents of a healthy fowl may be classified under the head of Staphylococci and sarcinae, or occasionally a streptococcus. There may be a diplococcus now and then, but in nearly all cases where plates have been made to separate out these diplococci the organism finally determined has given rise to a Staphylococcus form which has demonstrated in every case that the origin of most diplococci in the mucosa and feces of healthy birds are the result of some disintegration of the Staphylococcus or Streptococcus or the sarcinae. True diplococci are rarely present in the alimentary tract of healthy domestic birds. In only one case was a typical anaerobe identified, and this again demonstrates that the bacterial flora is far from a strictly anaerobic one. Many, and in fact, a large percentage of the organisms were facultative anaerobes, and there may have been some facultative aerobes, but by the use of the milk test and Buchner's method it is impossible either from the intestinal mucosa or the intestinal contents to isolate in any number the typical obligatory anaerobes. It is hoped that subsequently this work on the presence of obligatory anaerobes in the intestinal tract will be carried on to determine if possible the strictly anaerobic and strictly aerobic portions of the intestinal, and if possible to determine more concerning the conditions which give rise to excessive amounts of gas in health. The table shows the organisms isolated and cultivated from the feces of the different birds.

Consideration of the Percentages of Morphologically Different Bacteria in Feces.

In the discussion of these percentages in the tables which follow it should be noted that they are all approximate, and are given to establish in a general way the morphologically different bacteria in the feces of the healthy fowl. Each percentage has been obtained by making several counts of a slide, then taking the average of the several counts and the percentage recorded is that obtained by dividing this number by the total number of bacteria counted. By such a method it appears that it is possible to express the bacteriological picture exhibited by the gram positive and gram negative staining organisms as they exist in the fecal suspension.

Considering the total percentage of the gram positive organisms, the average for birds one day to six days old was 50.9 per cent.; of those seven days to thirteen days the average was 54.4 per cent., and those thirteen to eighteen days the average was 57.3 per cent. In the examination of the birds three to eight weeks for the three different periods an average considerably lower was established, i. e., 20.6 per ct., 22.8 per cent. and 19.1 per cent., the environment having considerable influence upon the gram positive and negative organisms present. The fecal suspension in birds twelve to fifteen weeks varied in the average for gram positive organisms, the averages being 36.3 per cent., 35.4 per cent. and 24.7 per cent. In the feces of birds from one to two years of age the averages for the Gram-positive bacteria of thirteen birds taken at three different periods were 43.3 per cent., 40.3 per cent. and 32.7 per cent, respectively. To sum up these gram-positive organisms present in a fecal suspension made from the feces of the healthy fowl, it may be concluded after considering the averages for 135 fecal suspensions of birds of different ages that under healthy conditions and under ordinary conditions of poultry environment that something less than 50 per cent. (approximately 40 per cent.) of the fecal bacteria in the healthy fowls are gram-positive organisms.

The percentage for the gram-negative organisms are higher, being represented by the Bacillus coli types of organisms other gram-negative bacilli and gram-negative micrococci. Birds one to six days old studied at three different periods gave percentages of 41.5, 38.5 and 42.5 respectively; those three to five weeks of age, 79.2, 76.8, 79.8, and those 12 to 15 weeks 52.6, 65.8 and 75.4, and those one to two years of age 56.4, 59.3 and 67.2. The average percentage of the averages of 135 determinations for the gram negative organisms in the fecal suspension was 62.0, which would be sufficient to warrant the conclusion that approximately 60 per cent. of all the organisms in the fecal suspension from healthy domestic fowl are gram-negative. The total micrococci in no case averaged above 30 per cent. The average for birds one to six days, seven to thirteen days and thirteen to eighteen days shows average percentages of 26.4, 23.9 and 25.2; those three to five weeks of age examined at three different periods showed 9.1, 11.8 and 11.2 per cent. respectively; and birds twelve to fifteen weeks 21.4, 15.4 and 9.8, and those one year old and over 15.2, 19.2 and 12.9. Although it often appears as if the micrococcic flora of a bird fecal suspension is large, it has never yet in this work even approached anywhere near 50 per cent. By far the larger number of micrococci are represented by the sarcinae forms.

From the four tables it may be noted that the B. coli type represent the larger part of the gram-negative percentage, the other negative bacteria representing only a small part of the percentages reported for

Table showing the percentages of morphologically different Bacteria in young chicks.

Type of Bacteria	Precentages										
	1 Day Old				3 Days Old			6 Days Old			
	Bird 80	Bird 81	Bird 77	Bird 70	Bird 73	Bird 74	Bird 78	Bird 79	Bird 73	Bird 72	Bird 75
B. Coli Type*											
9- 3-09	13.4	35.3	51.6	33.1	24.0	59.4	40.9	36.2	38.2	51.4	55.0
9-10-09	18.1	39.1	63.2	28.8	36.1	52.7	31.9	37.1	38.4	42.4	53.2
9-15-09	18.1	33.6	56.5	45.6	34.5	47.4	22.6	47.2	46.9	28.7	39.8
Other Gram Negative Rods											
9- 3-09	49.2	00.0	00.0	00.0	00.0	00.0	00.0	00.0	14.0	10.1	00.0
9-10-09	13.8	00.0	00.0	00.0	00.0	00.0	00.0	00.0	10.7	11.6	23.5
9-15-09	12.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	7.5	27.0	00.0
Gram Positive Rods											
9- 3-09	13.8	22.5	48.3	44.9	44.7			43.6	26.9	25.4	
9-10-09	41.7	33.6	36.8	37.4	39.8	16.3	24.7	46.2	28.2	30.6	
9-15-09	41.1	34.9	43.4	30.1	32.7	26.6	35.6	37.0	18.5	26.4	26.9
Gram Negative Micrococci											
9- 3-09	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
9-10-09	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
9-15-09	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
Gram Positive Micrococci											
9- 3-09	23.3	42.2	00.0	20.2	31.2	40.5	59.0	20.1	20.7	12.9	20.3
9-10-09	25.9	27.2	00.0	33.7	24.0	30.6	43.2	16.6	22.6	16.7	23.2
9-15-09	28.6	31.4	00.0	24.1	32.7	25.9	41.6	15.5	26.7	17.7	33.2
Total Gram Positive Bacteria											
9- 3-09	37.1	64.7	48.3	65.1	75.9	40.5	59.0	63.7	47.6	38.3	20.3
9-10-09	67.6	60.8	36.8	71.1	63.8	46.9	67.9	62.8	50.8	47.3	23.2
9-15-09	69.7	66.3	43.4	54.2	65.4	52.5	77.2	52.5	45.2	44.1	60.1
Total Gram Negative Bacteria											
9- 3-09	62.6	35.3	51.6	33.1	24.0	59.4	40.9	36.2	52.2	61.5	55.0
9-10-09	32.1	39.1	63.2	28.8	36.1	52.7	31.9	37.1	49.1	54.0	76.7
9-15-09	30.1	33.6	56.5	45.6	34.5	47.4	22.6	47.3	54.4	55.7	39.8
Total Micrococci											
9- 3-09	23.3	42.2	00.0	20.2	31.2	40.5	59.0	20.1	20.7	12.9	20.3
9-10-09	25.9	27.2	00.0	33.7	24.0	30.6	43.2	16.6	22.6	16.7	23.2
9-15-09	28.6	31.4	00.0	24.1	32.7	25.9	41.6	15.5	26.7	17.7	33.2

*Note—Bacilli 0.4 microns wide and from 1.0 to 2.5 microns long were classed as B. coli type.

Table showing the percentages of morphologically different Bacteria in birds from 3 to 5 weeks old.

Type of Bacteria	Precentages											
	Bird 63	Bird 67	Bird 70	Bird 65	Bird 64	Bird 61	Bird 62	Bird 66	Bird 60	Bird 68	Bird 69	Bird 70
B. Coli Type												
9-21-09	*1	*1	91.3	81.2	63.8	25.9	62.5	48.9	49.8	79.3	97.6	89.0
9-30-09			95.2	80.3	82.5	37.4	57.2	41.7	58.4	85.7	90.3	90.0
10-6 -09			95.6	89.4	71.2	50.4	66.2	46.9	22.7	80.7	89.5	92.1
Other Gram Negative Rods												
9-21-09	87.1	90.0	8.1	10.1	28.3	11.9	*2	13.5	9.1	2.0	0.0	1.2
9-30-09	85.1	85.0	3.3	10.3	2.1	10.8		0.9	3.1	2.2	2.0	2.2
10-6 -09	88.5	89.0	1.3	3.4	5.1	8.8		7.1	8.9	5.0	0.0	2.4
Gram Positive Rods												
9-21-09	12.8	9.0	0.5	8.2	3.9	25.8	14.0	23.6	30.2	10.5	0.0	0.0
9-30-09	10.2	10.4	2.5	10.0	0.0	29.3	10.8	29.8	15.7	6.2	4.5	3.0
10-6 -09	9.3	10.1	3.1	6.4	12.2	23.5	13.3	34.2	8.2	7.2	6.4	4.1
Gram Negative Micrococci												
9-21-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-30-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-6 -09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	5.2	0.0	0.0
Gram Positive Micrococci												
9-21-09	0.0	1.0	0.0	0.0	3.9	36.9	23.4	13.8	10.7	6.5	2.4	9.7
9-30-09	4.2	4.5	0.0	0.0	15.2	22.6	31.8	27.7	22.6	5.7	3.2	4.7
10-6 -09	2.2	0.0	0.0	0.0	10.7	17.0	20.5	11.5	30.2	2.2	4.0	1.6
Total Gram Positive Bacteria												
9-21-09	12.8	10.5	0.5	8.2	7.8	62.7	38.3	37.4	40.9	17.0	2.4	9.7
9-30-09	14.4	14.9	2.5	10.0	15.2	51.7	42.6	57.5	38.3	11.9	7.7	7.7
10-6 -09	11.5	10.1	3.1	6.4	22.9	40.5	33.8	45.7	38.4	9.4	10.4	5.7
Total Gram Negative Bacteria												
9-21-09	87.1	90.0	99.4	91.3	92.1	37.8	62.5	62.4	58.9	81.3	97.6	90.2
9-30-09	85.1	85.0	95.8	90.3	84.6	48.2	57.2	42.6	61.5	87.9	92.3	92.2
10-6 -09	88.5	89.0	96.9	92.7	76.1	59.2	66.2	54.0	61.4	90.2	89.5	94.5
Total Micrococci												
9-21-09	0.0	1.0	0.0	0.0	3.9	36.9	23.4	13.9	10.7	6.5	2.4	9.7
10-6 -09	4.2	4.5	0.0	0.0	15.2	22.6	31.8	27.7	22.6	5.7	3.2	4.9
10-6 -09	2.2	0.0	0.0	0.0	10.7	17.0	20.5	11.5	60.0	7.4	4.0	1.6

*1—Included in other Gram Negative Rods. *2— " " B. Coli Type.

Table showing the percentages of morphologically different Bacteria in feces of birds 12 to 15 weeks old.

Type of Bacteria	Percentage								
	Bird 300	Bird 302	Bird 303	Bird 305	Bird 306	Bird 307	Bird 308	Bird 310	Bird 311
B. Coli Type									
8-26-09	50.0	58.6	44.0	20.0	41.2	52.0	0.07	60.5	52.0
8-31-09	65.7	67.1	64.2	56.6	56.8	65.2	12.8	60.8	48.9
9- 8-09	70.2	71.2	68.3	75.8	75.7	42.2	55.8	65.9	56.0
Other Gram Negative Rods									
8-26-09	22.6		16.0	0.0	7.9	12.6	0.0	28.1	10.0
8-31-09	12.8		12.9	4.4	10.0	11.2	0.0	12.0	21.0
9- 8-09	11.1		1.4	10.5	4.5	5.7	0.0	10.1	26.0
Gram Positive Rods									
8-26-09	29.1	29.8	38.8	32.0	4.7	9.4	69.7	10.5	18.0
8-31-09	22.0	21.2	23.0	11.3	8.7	8.8	56.7	15.2	12.7
9- 8-09	19.9	24.2	30.2	4.6	6.5	10.5	20.9	21.9	16.7
Gram Negative Micrococci									
8-26-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8
8-31-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9- 8-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gram Positive Micrococci									
8-26-09	0.0	11.4	0.0	48.4	46.8	26.3	69.7	0.0	14.0
8-31-09	0.0	10.9	0.0	27.8	25.5	14.7	30.5	11.8	18.1
9- 8-09	0.0	5.7	0.0	10.0	13.7	10.5	24.2	2.7	0.8
Total Gram Positive Bacteria									
8-26-09	29.1	41.2	38.8	80.4	50.5	35.7	99.9	10.5	32.0
8-31-09	22.0	32.1	23.0	39.1	34.2	23.5	87.2	27.0	31.0
9- 8-09	19.9	29.9	30.2	14.6	20.2	21.0	45.1	23.9	17.5
Total Gram Negative Bacteria									
8-26-09	71.6	58.6	60.0	20.0	48.3	64.6	0.0	88.6	62.0
8-31-09	88.5	67.1	77.1	60.8	66.8	76.5	12.8	72.8	69.9
9- 8-09	81.3	71.2	69.7	86.3	80.2	79.9	55.8	76.0	82.0
Total Micrococci									
8-26-09	0.0	4.4	0.0	48.4	46.8	26.3	30.2	0.0	27.8
8-31-09	0.0	10.9	0.0	27.8	25.5	14.7	30.5	11.8	18.1
9- 8-09	0.0	5.7	0.0	10.0	13.7	10.5	24.2	23.9	8.0

Table showing the percentages of morphologically different Bacteria in feces of birds over 1 year old (1-2years).

Type of Bacteria	Percentage												
	Bird 69	Bird 77	Bird 56	Bird 75	Bird 51	Bird 52	Bird 74	Bird 62	Bird 65	Bird 73	Bird 66	Bird 78	Bird 59
B. Coli Type													
10-15-09	22.2	32.3	80.0	39.1	64.8	54.1	63.1	24.5	42.2	56.1	36.1	37.5	53.3
10-22-09	22.3	35.0	75.2	48.9	41.8	73.4	67.8	34.9	61.0	45.5	34.6	49.7	41.0
11- 6-09	37.0	28.7	60.8	28.0	71.1	56.3	69.6	53.2	62.8	33.1	43.4	48.7	44.2
Other Gram Negative Rods													
10-15-09	7.6	12.7	5.2	30.8	3.2	12.2	6.5	17.9	10.3	1.0	00.0	0.0	0.0
10-22-09	3.1	5.2	0.0	0.0	11.7	6.4	9.9	16.7	10.9	7.8	4.3	0.0	21.3
11- 6-09	6.0	3.7	9.2	24.8	6.1	15.5	5.6	13.9	12.2	66.8	0.0	0.0	10.2
Gram Positive Rods													
10-15-09	18.8	23.1	14.4	30.0	17.3	33.6	30.2	39.7	35.6	42.1	31.9	45.4	23.6
10-22-09	22.0	16.1	24.7	20.6	24.7	20.1	21.1	18.9	18.3	46.6	29.3	35.3	20.0
11- 6-09	27.7	35.6	30.0	46.9	22.7	28.1	20.5	18.6	14.5	0.0	9.6	40.6	27.4
Gram Negative Micrococci													
10-15-09	11.9	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	3.7	0.0	0.0
10-22-09	14.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	0.0	0.0	10.6	0.0	0.0
11- 6-09	14.5	0.0	0.0	0.0	0.0	0.0	0.0	14.1	0.0	0.0	34.5	0.0	0.0
Gram Positive Micrococci													
10-15-09	38.8	31.1	0.0	0.0	14.5	0.0	0.0	12.8	11.8	00.0	27.8	0.0	23.6
10-22-09	38.0	43.8	0.0	30.4	21.7	0.0	0.0	10.4	9.5	23.9	20.9	14.9	17.5
11- 6-09	14.5	31.8	0.0	0.0	0.0	0.0	4.1	0.0	10.5	12.4	11.2	11.2	18.1
Total Gram Positive Bacteria													
10-15-09	57.6	54.2	14.4	30.0	31.8	33.6	30.2	52.5	47.4	42.1	59.7	62.4	47.2
10-22-09	60.0	59.9	24.7	51.0	46.4	20.1	21.1	29.3	27.8	46.6	50.2	50.4	37.2
11- 6-09	42.2	67.4	30.0	46.9	22.7	28.1	24.6	18.6	25.0	0.0	22.0	51.8	45.5
Total Gram Negative Bacteria													
10-15-09	41.7	45.0	85.2	69.9	68.0	66.3	69.6	47.5	52.5	57.1	39.8	37.5	53.3
10-22-09	39.4	40.2	75.2	48.9	53.5	79.8	77.7	70.5	71.9	53.3	49.5	49.7	62.3
11- 6-09	57.5	32.4	69.8	52.8	77.2	71.8	75.2	81.2	75.0	99.9	77.9	48.7	54.4
Total Micrococci													
10-15-09	50.7	31.1	0.0	0.0	14.5	0.0	0.0	17.9	11.8	0.0	31.5	17.0	23.6
10-22-09	52.0	43.8	0.0	30.4	21.7	0.0	0.0	29.3	9.5	0.0	31.5	14.9	17.5
11- 6-09	29.0	31.8	0.0	0.0	0.0	0.0	4.1	14.1	10.5	0.0	45.7	11.2	18.1

the total gram-negative bacteria. Negative micrococci are rarely present among the intestinal bacteria of healthy domestic fowls. In bird 68 of the three to five weeks classes they were found; in bird 311 of the twelve to fifteen week classes, and in birds 62 and 66 of birds one to two years old.

Free spores and a very few spirilla were observed in a few slides; but the object of this work has been to consider principally those bacteria present under ordinary conditions in health, and those cited appear to be representative for such conditions.

Animal Organisms Detected in Feces and Intestinal Mucosa.

The protozoa represent by far the greater number of animal organisms determined in the intestinal contents and mucosa of healthy fowls. Although widely distributed in nature, it is interesting to note that very few are able to find their way to the intestinal tract of the healthy and vigorous bird. The parasitic protozoa are very important factors in disease, and it is in the field of parasitology that the cause of so many of the intestinal diseases must be found. Certain of the protozoa may be common inhabitants of the digestive tract, yet in the examination of the mucosa of the birds retained for this study surprisingly few were found.

In subjects 303 and 309 Euglena* was present in considerable numbers.

In this same bird paramecium, belonging to the class of infusoria was detected. The length of these organisms was about 200 microns, and the body was long and spindle shaped, containing a large oval nucleus, within which were located smaller nucleoli, and there were two contractile vacuoles. These vacuoles contained rosetted canals and the whole organism corresponded closely to Dolflein's description for Paramaecium caudatum (Ehrbg). In subject 308 several Heterakis worms were found. An examination of the intestine revealed nothing which would indicate that these animal organisms were causing any pathological lesions. In nearly all excessive round or tapeworm infestations, many subjects harboring such organism exhibited marked inflammatory lesions along the intestinal canal. These subjects, however, were birds which were thoroughly infested and far from healthy birds. Those showing lesions, when tapeworms were present were subjects described in a recent communication.*

Large numbers of worms present in the intestines may and probably do cause the starting of many conditions which allow other pathogenic organisms to find a suitable environment for growth. The presence of them in a flock is indicative of infestation on the premises, and if poultry are to be raised under the best conditions, perform all the physiological functions probably and be maintained in health, methods for their eradication should be sought and practiced. Large numbers of round worms in the intestines cannot but induce nervousness and ultimately male function of the alimentary canal. Cole, Hadley and Kirkpatrick (1910) in a study of "Blackhead in Turkeys," state, under the heading, "Relation of Bacteria and Other Organisms to the Disease: "While several other organisms were found frequently in the alimentary tract of fowls and turkeys, where they sometimes produce several lesions, as in the case of the flagellate Cercomonas, or the nematode worms, Heterakis and Oxyuris, it is very doubtful if these organisms play a part in rendering the birds more susceptible to coccidiosis, although they may damage the epithelial lining of the intestines to a considerable extent. On the other hand, multiple infections are extremely common, and it cannot be doubted that a severe flagellate infection of the large intestines or ceca, and the invasion of the small intestines by Taenia infundibuliformis or lesions caused in the tips of the caeca by Heterakis, may have great influence in hastening a fatal issue in any bird already suffering from even a narrowly localized coccidiosis."

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*All the protozoa were identified according to Doflein's classification. Lehrbuch der Protozoenkunde. Eine Darstellung der Naturgeschichte der Protozoen mit besonderer Beruchksichtigung der Parasitischen und Pathogenen Formen.

*Geo. Edward Gage and C. L. Opperman, Nodular Taeniasis or a Tapeworm Disease of Fowls. Md. Agr. Exp. Sta. Bull. No. 139.

The presence of these nematode or trematode worms in apparently healthy birds may and probably do give rise to malnutrition which invariably will result in intestinal disturbances. The above authors (1910) also state concerning certain conditions in "Blackhead in Turkeys:" "The long period of emaciation which many birds undergo, and the stunted bodies and organs of birds which have carried, possibly since the chick stage, a nematode or a Taenia infection, give evidence of the faulty assimilation resulting in the destructively unbalanced metabolism which obtains in birds suffering from the presence of any of these epithelium-destroying parasites."

Subject 309 exhibited bodies which appeared to be coccidium. Although this bird appeared in good health when she was killed, later it was found that there was a marked intestinal inflammation, which was due either to the presence of the heterakis worms or the invading coccidia. This is undoubtedly a case of chronic infection and explains in a manner a condition which exists when birds appear perfectly healthy at night and are found dead the next morning. From different parts of the State of Maryland just such descriptions of death have been received at this laboratory. On several occasions it has been impossible to explain these deaths in any other way.

Subject 64, a bird about four weeks old, harbored in the intestinal contents several protozoan bodies. These were undetermined, but in so far as it was possible to judge were neither the pathogenic cercomonade or the coccidium. The mucosa was free from any animal organic or parasitic invasion. In nearly all the young chicks up to four weeks of age animal organisms were absent; and it is quite safe

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1910, Cole, Hadley and Kirkpatrick, Blackhead in Turkeys: A Study in Avian Coccidiosis, Rhode Island Agricultural Experiment Station, Bulletin No 141, page 201.

to say that young chicks reared under sanitary conditions do not harbor to any extent either in the fecal matter or intestinal mucosa animal organisms. Older birds may harbor round worms and tapeworms and even parasites for considerable time without showing any external signs of their presence.

The Significance of the Fermentation Test Tube in Determining Intestinal Conditions of the Domestic Fowl.

The most significant data gained by the inoculation of the fecal matter into the fermentation tube was the microscopic picture furnished when the sediments from such fermentation tubes were stained by Gram's method. It has been helpful in several instances in gaining a clew to the organisms which preponderates in the intestinal tract of the domestic fowl, and it has aided in checking up some of the work on the percentages of morphologically different bacteria in the feces. The uses to which this method may be employed as a means of diagnosing intestinal conditions in the domestic fowl appear to be many. This field would require special investigation and appears to be a fruitful one. Dr. Herter (1910) has shown clearly the possibilities afforded by study of the gram-stained sediments from dextrose fermentation tubes in the study of human feces and in consideration of the limited observations made with the birds on this experiment, it appears that there should be just as many diagnostic facts concerning intestinal conditions to be gained from the study of the feces of the domestic fowl.

Summary.

In consideration of this study of the bacteria and animal organisms found in the intestinal mucosa of sixty birds of different ages and in the feces of forty-five the following summaries may be noted:

1. The intestinal flora of healthy domestic fowls varies to some extent with the conditions of poultry environment and different stages of life.

2. It is impossible to grow all the species present in the feces, as shown by a stained preparation, on artificial culture media. A considerable number are undoubtedly dead. The death of these cells is probably due to the same agents which act upon the intestinal bacteria in the human subject. Most of the classics on intestinal bacteriology accord the death of such cells primarily to the unfavorable products of their own growth, the effect of which may be increased by the concentration of the intestinal contents, the absorption of food material, and bacterial antagonism of other species.

3. Although these tests have been limited, they have been ample to show that it is possible by the bacteriological examination of smears of a fecal suspension, by the special methods of MacNeal, Latzer and Kerr to determine approximately the percentages of morphologically

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1907, Herter, Bacterial Infections of the Digestive Tract. MacMillan Company, 1907, page 130-135.

different bacteria in the feces of healthy domestic fowl of different ages. It has been possible to establish the approximate percentages of gram-negative and gram-positive organisms present in the feces of such birds.

4. It may be stated that approximately 60 per cent. of the organisms in the domestic fowl do not stain by Gram's method, and that under ordinary conditions of poultry environment approximately 40 per cent. are gram-negative in their staining reactions. The B. coli type of organisms represent the larger part of the gram-negative percentage.

5. The intestinal mucosa of the healthy domestic fowl may harbor a large and varied flora which is constant only to a certain extent. Few obligatory anaerobes are present.

6. B. coli was the preponderating organism in the intestinal mucosa and the feces, and undoubtedly it plays the same role physiologically that it does in the alimentary canal of higher animals. Since it is so omnipresent it is undoubtedly an obligate bacteria, and under some circumstances renders service by producing conditions which discourage the growth of many harmless and harmful species which the bird cannot exclude readily.

7. The absence of large numbers of obligatory anaerobes of the B. putrificus type would indicate that the intestinal conditions in the healthy domestic fowl are not inducive for anaerobiosis.

8. Chickens reared under sanitary conditions do not harbor many animal organisms. In several subjects in the best of health *Euglena* and *Paramecium caudatum* were found by examinations of fresh preparations. Heterakis worms and tapeworms are found in healthy birds, but their presence must be looked upon as indicative of some unsanitary condition in the poultry yards. They may cause intestinal lesions, which may later be the starting point of more serious infections. Tapeworms in small numbers, according to observations made after death, do not appear to cause serious pathological effects.

9. The presence of *Cladothrix asteroides* in the intestinal mucosa has not in any instance appeared to be pathogenic for the domestic fowl in any stages of its life.

10. The study of the fermentation and gram-stained sediments in dextrose bouillon inoculated with the mixed fecal flora in fermentation tubes promises to afford an interesting method for the study of intestinal conditions in the domestic fowl.

In conclusion I wish to express my indebtedness to Mr. C. L. Opperman, former Poultryman at this Station, for his assistance in this work, and to Mr. A. C. Adams, Assistant Chemist in State work at the Maryland Agricultural College, for his help with the computations.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

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BEE KEEPING IN MARYLAND.

I. THE STATUS OF BEE KEEPING IN THE STATE.

By T. B. Symons.

Introduction.

The keeping of bees for profit is in its infancy in Maryland. Those who gain their entire livelihood from this business are few, but there are thousands who keep bees as a side issue to their regular business for either profit or pleasure. There is no industry in whose progress and protection the farming class as a whole should be more interested than in apiculture. It does not follow from this statement that all farmers should be bee keepers, for it is not the aim of the friends of apiculture to greatly increase the number of persons keeping bees, but to make better bee keepers of those already in the business. In the light of comparatively recent discoveries of the existence of serious communicable diseases among bees, it is specially urged that only those who are prepared to give the apiary proper attention, should undertake to keep bees even if only for pleasure.

The honey bee is an important factor as a pollenizing agent, especially in cross-pollinating the blossoms of many of our fruits. It has long been known that the blossoms of many varieties of fruit, as well as other plants, require cross pollination to set a full crop. It is probable that no other insect is superior to the honey bee in performing this service. Many practical fruit growers keep bees for this purpose, and the growers of the vegetables under glass, regularly introduce bees into their green houses to pollinate cucumbers and other flowers. Probably this useful insect can be given credit for causing some of our best varieties that have originated from seedlings. As the people of this state become more and more interested in horticulture, they must at the same time, bear in mind the protection of the honey bee, which aids them in producing full crops.

Aside from the great service rendered by the honey bee in cross pollinating the flowers of fruit trees and grains, its ability to manufacture the nectar into a most palatable food, which otherwise would undoubtedly be lost to man, makes this insect a subject of unusual interest to the general public. It may not be out of place to comment here that notwithstanding the great increase in recent years in the manufacture of adulterated foods, no one has yet devised a method to manufacture comb honey. Moreover, with the passage of the Pure Food Law by Congress, inferior substitutes for extracted honey can no longer lawfully be sold under the name honey.

While the State of Maryland offers abundant opportunity for successful bee keeping, there are comparatively few progressive bee keepers in the state. There are however, thousands who keep a few colonies. These are too often kept under conditions, which are a menace to the industry.

While Maryland has not been prominent as a honey producing state, yet she has furnished some distinguished bee keepers. For several years Rev. L. L. Langstroth, who may be justly called the father of American apiculture, resided in Baltimore. His perfection of the movable frame hive revolutionized the industry in this country. Probably no improvement has been so universally adopted by the trade as the Langstroth's hive, and his writings on bee keeping speak for his genius. One of the hives originally owned by Mr. Langstroth was exhibited by Mr. Chas. H. Lake, a venerable and enthusiastic bee keeper of the state, at the 1909 meeting of the Maryland State Bee Keepers Association. Richard Colvin, who was one of the first to introduce the Italian bee to the United States, also lived in Baltimore. No doubt the enthusiasm and knowledge of the business of these men were a great incentive to Maryland bee keepers at that time.

The first work taken up at this Institution was conducted by Mr. Chas. H. Lake, now of Baltimore. Mr. Lake is a practical bee keeper, and a keen observer of the bees and their activities. He successfully conducted a large apiary at the College from 1896 to 1899. During these years he did much to educate the bee keepers of the state, by making exhibits and otherwise giving information regarding bee keeping.

Prior to the fall of 1910, practically nothing had been done by this department to aid bee keeping. At this time through the efforts of the department, a State Bee Keepers Association was formed for the purpose of bringing the bee keepers of the state together, so that a general exchange of ideas would aid in bettering the conditions in the State. At the same time there was inaugurated some cooperative work with the Bureau of Entomology, United States Department of Agriculture, which made possible a limited investigation of the status of the industry in the State. A preliminary report of this investigation by the writer, together with a discussion of the management of the apiary by A. H. McCray, Apicultural Assistant, U. S. Department of Agriculture, is here given with the hope that suggestions made will be helpful to the bee keepers.

The Needs of Such an Investigation.

As pointed out above, prior to 1908, very little had been done in this State to promote scientific apiculture. The only information available concerning the industry in the State was that given by the census of 1900. It was there stated that 5,098 farmers in Maryland had reported 28,013 colonies. These bees produced in 1899, 306,788 pounds of honey and 7,860 pounds of wax, valued at $38,857. Few people are aware that the industry amounted even to this much, as it had not been promoted in any organized manner, and even the few individual expert bee keepers had not properly advertised their business.

While brood diseases of bees had been reported from Maryland by the Bureau of Entomology United States Department of Agriculture, no extensive attempt had been made to ascertain the distribution of these diseases, or to prevent their spread by the education of the bee keeper in the best method of treatment and prevention. No attempt had been made to increase the demand for pure honey in our markets, and thus curtail the sale of the cheap manufactured syrup compounds. The bee keepers who were in the business, were working independently and not cooperatively, and those who desired to improve their apiaries had no opportunity to exchange views with their associates in the business, and few were aware of the sources for up-to-date information concerning the business.

Results of Cooperative Work.

At the outset, this limited investigation in cooperation with the Bureau of Entomology, it was necessary to secure the names of as many bee keepers in the state as possible, in order to communicate with them and thereby learn the status of the industry at that time. A report blank asking various questions concerning the apiary, was sent to each bee keeper, whose name could be secured. A list of the publications of the Bureau was also inclosed so that the bee keeper might indicate in which he was especially interested. By this means valuable information was secured, and made possible, a preliminary study of the needs and possibilities of the industry. The desire of the bee keepers for information, was indicated by their request for one or all of the publications of the Bureau of Entomology on Apiculture.

Distribution of Bees in the State.

From information at hand, it would seem that about 80% of the bees in Maryland are kept on the Western Shore. Of this, 80% on the Western Shore, about 74% are kept in the Northern and West counties. No explanation can be given for this condition, as bees would probably do better in the Eastern and Southern parts of the State, than in other regions. However, this distribution indicates the need of development of the industry and the education of the people to the opportunities for bee keeping in other sections. Thus far, Montgomery County is the banner county for the bee industry, with Frederick, Garret and Baltimore counties closely following. The distribution in the Western counties is about equal. This distribution explains in part, the occurrence of disease. The Eastern Shore, as far as known, is free of brood diseases, as is likewise Southern Maryland. This is no doubt due in part to the scarcity of bees in those regions.

Increase and Loss of Colonies.

From figures received it seems that during 1908, there was an increase of 33% in the number of colonies, while during 1909 only 16% increase was reported, making an average of 24.5% each year. Practically no difference in figures of increase of colonies can be noted in relation to territory where the bees are kept. The reported winter loss also does not seem to differ in the different sctions. From data received, it is believed that most of the winter loss in this State is due to lack of attention, and, in many cases, to ignorance on the part of the bee keepers as to the proper care of a colony prior to wintering. Often too great a quantity of honey is removed, and artificial feeding is seldom practised to make up for the loss. Thus the colony is weakened by a meager food supply, the vitality of the bees becomes greatly diminished and, they are therefore, much more susceptible to cold and dampness during the winter.

This condition is no doubt, also largely responsible for complaints against the wax moth that have been made by so many bee keepers, who have cooperated by giving information concerning their apiaries. It is known that this moth is able to gain a foothold only in those instances where the colony has been so depleted as to render it incapable of overcoming the attack. Moreover, winter loss is often really due to disease having previously weakened the colony. The large number of complaints of heavy winter loss and moth depredation, would indicate that brood diseases are more generally spread in the State than we even now know.

Production of Honey and Wax.

Calculating the average pounds of comb and extracted honey per bee keeper of those who have reported, and applying this average to the probable number in the State, the approximate annual production of honey is about 500,000 pounds, of which only about 15% is extracted. This amount does not nearly approximate the quantity of honey used in the State annually, even at the present limited demand in the markets of our cities and towns.

As pointed out previously, this product has not been advertised, directing attention to its usefulness and adaptability to the diet of every day life. It is believed that a larger per cent of honey should be extracted and put on the market in convenient sized bottles, jars and larger containers, such as quarts, gallons, etc. Undoubtedly much of the honey produced in Maryland is too dark to make first class comb honey, and the honey flows are slow, which is also not favorable for comb honey production.

As far as known, little or no honey is exported from Maryland. On the other hand, we have definite information from wholesale dealers that quantities of honey are imported into the State from the northern and western states. Even under the present demand, there is great opportunity for the promotion of the industry in the State from the point of view of strict business possibilities alone. Moreover, the total approximated crop of 500,000 pounds in the State is very meager when it is considered that single apiaries in western states often produce from 50 to 100 tons in a year, in locations that are little better for keeping bees than are many parts of Maryland.

The production of bees wax is correspondingly low in the State. Based on an estimate similar to that for honey, the total crop would amount to about 10,000 pounds per year. The common practise of bee keepers to make wax only from old comb, makes the annual production variable. Outbreaks of disease or severe winter losses ordinarily cause an increase in wax output the following year. The commercial value of this product is an additional incentive for increasing the industry in the State.

Sources of Honey.

Every bee keeper should familiarize himself with the bee flora of his locality. While it is sometimes very difficult to learn the sources from which bees secure their products, yet every effort should be made to ascertain the principal nectar yielding plants of a neighborhood, and the approximate dates of beginning and ending of each important honey flow.

Clovers are considered by far the most important honey plants in Maryland. Of all those reported, the clovers are placed as the principal surplus plants. White clover is the most useful where it occurs in large areas, and the honey secured from this plant ranks high in color and flavor. Alsike clover, which is an excellent nectar yielding plant, is now being grown quite generally in the State. A common practice among farmers in sowing clover for forage, is to mix the different clovers which increases the value of such fields to the bee keeper. Many reports have been received, giving crimson clover as an excellent surplus plant. It is also being more generally grown in the eastern, southern and central parts of the State. While red clover is most commonly grown by farmers and has more or less continuous bloom, it is ordinarily not useful to the honey bee. Sweet clover, which some consider a weed is common along the roadsides in many parts of Maryland, and is an excellent honey plant. Inasmuch as this plant is useful, being a legume, it is worthy of more attention in this State.

Fruit Bloom. The bloom of apple, peach, pear and cherry, is given in the reports as next in importance as honey producing plants. These fruits are common throughout most parts of the State. No surplus honey is secured from fruit bloom as a rule, but the colonies are stimulated by such early bloom to early brood-rearing.

Buckwheat. This Plant ranks third, according to information received as a surplus plant. This crop is not generally grown except in the western counties.

Locust and Basswood. The black locust ranks high as a yielder of nectar. It is a hardy tree and found commonly over the State. In some sections basswood is still a prominent source of surplus. Like tulip poplar, however, these trees are being largely cut from our woodlands.

Miscellaneous. Goldenrod and asters are reported as important in providing surplus for wintering, while the bloom of sumac, wild raspberry and blackberry are among the more important wild plants that abound throughout the State, that are abundant honey producers. The maples are usually considered as valuable for bees, principally for pollen.

As a rule, too little attention is given by the bee keeper to the honey plants of the locality. A bee keeper should know the principal honey plants of the vicinity, when they come into bloom, so as to manipulate the colonies to obtain the maximum surplus.

The following list of plants constitutes a partial list of the bee flora of Maryland, and their general distribution. Mounted specimens of these plants with dates giving their approximate value as honey plants in northeastern sections of the State, were exhibited at the State Bee Keepers Association in Baltimore, November 30 and December 1, 1910, by Mr. J. Ford Sempers, of Aiken, Md., to whom the writer is greatly indebted. The data given on these specimens has been supplemented by data concerning their range in the State, and their usefulness in other sections.

PARTIAL LIST OF BEE FLORA OF MARYLAND.

Common Name.	Scientific Name.	Date of Flowering.	Apicultural Value.	Distribution in Maryland.
Chickweed.	Alsine Media.	Feb. and Mar.	Slight value.	Common Throughout State.
Alder.	Alnus rugosa.	Feb. and Mar.	Early contributory species.	Common Throughout State.
Hazel Nut.	Corylus Americana.	Feb. and Mar.	Slight value.	Not Common Throughout State.
Red or Swamp Maple.	Acer rubrum.	Mar. and Apr.	Contributory.	Common Throughout State and elsewhere.
Daffodil.	Narcissus Pseudo-narcissus.	Mar. and Apr.		Infrequently cult.
Crocus.	Crocus vemus.	Mar. and Apr.	Slight value. Visited for pollen.	Infrequently cult.
Hyacinth.	Hyacinthus oventales.	Late Mar., Early Apr.	Slight value.	Infrequent cult.
Swamp Pink.	Helonias hulbata.	April.	Slight value.	Infrequent cult.
Golden Bell.	Forsythia viridissima.	Mar. and Apr.	Slight value.	Common Throughout State.
Arbutus.	Epigaea repens.	April.	Slight value.	Common Throughout State.
Peach.	Prunus Persica.	Mar. and Apr.	Important contributory species.	Common Throughout State.
Cherry.	Prunus cerasus.	April.	Important contributory species.	Common Throughout State.
Plum.	Prunus domestica.	April.	Important contributory species.	Common Throughout State.
Missouri Currant.	Ribes aureum.	April.	Slight value.	Common in Coastal and Midland Zones.
June Berry.	Amelanchier canadensis.	April.	Slight value.	Cult. Common.
American Crab Apple.	Pyrus coronaria.	Apr. and May.	Slight value.	Common Throughout State.
Cultivated Apple.	Pyrus Malus.	Apr. and May.	Contributory to surplus.	Common Throughout State.
Cockspur Thorn.	Crataegus Crus-galli.	Apr. and May.	Slight value.	Uncommon Throughout State.
Lilac.	Syringa vulgaris.	April.	Slight value.	Commonly Cult.
Dandelion.	Taraxacum officinale.	Apr. to Oct.	Contributory.	Common Throughout State.
Pink Azalea.	Azalea nudiflora.	May.	Occasionally visited.	Common Throughout State.
Huckleberry.	Gaylussacia baccata.	May.	Slight value.	Common Throughout State.

PARTIAL LIST OF BEE FLORA OF MARYLAND—*Continued.*

Common Name.	Scientific Name.	Date of Flowering.	Apicultural Value.	Distribution in Maryland.
Black Gum.	Nyssa sylvatica.	May.	Contributory species.	Common Throughout State.
Clematis.	Clematis Caerulea.	May.	Slight.	Rare Throughout State.
Horse Chestnut.	Aesulus Hippocastanum.	May.	Slight.	Rare Cult. Throughout State.
Wild Black Raspberry.	Rubus occidentalis.	May.	A surplus plant.	Common Throughout State.
Crimson Clover.	Trifolium incarnatum.	May.	A surplus plant.	Common Throughout State.
Quince.	Cydonia vulgaris.	May.	Slight.	Not Common Throughout State.
Blackberry.	Rubus villosus.	May.	Occasionally visited.	Some species of blackberry common all over State. Coastal Zone.
Tulip Tree.	Liriodendron Tulipifera.	May and June.	Valuable surplus plant.	Common Throughout State.
Hairy or Winter Vetch.	Vicia villosa.	May and June.	Surplus.	Uncommon Throughout State.
Black Locust.	Rodinia Pseudacacia.	May and June.	Important surplus plant.	Common Throughout State.
Alsike Clover.	Trifolium hybridum.	May and June.	Good surplus plant.	Common Throughout State.
Sumac.	Rhus hirta.	June.	Surplus.	Frequent Throughout State.
Rape.	Brassica Napus.	June.	Visit sparingly.	Cult. Common Throughout State.
Wild Radish.	Raphanus Raphanistrum.	June.	Visited for nectar.	Rare Throughout State.
Orchard Grass.	Dactylis glomerate.	June.	Contributory.	Common Throughout State.
Borage.	Borage officinalis.	June.	Contributory.	Rare Throughout State.
Grapes.	Virtis (Species).	June.	Slight value.	Common Throughout State.
Magnolia.	Magnolia Virginiana.	June.	Slight value.	Frequent in Coastal Zone.
Strawberry.	Fragaria Virginiana.	June.	Contributory.	Common Throughout State.
Persimmon.	Diospyros Virginiana.	June.	Surplus.	Common in Coastal and Midland Zones.
Mountain Sumac.	Rhus copallina.	June and July.	Contributory specie.	Common Throughout State.
White Clover.	Trifolium repons.	June and July.	Main surplus plant.	Common Throughout State.
Chinquapin.	Castanea pumila.	June and July.	Occasionally visited.	Frequent Throughout State.
Am. Chestnut.	Castanea dentata.	June and July.	Surplus, poor qual.	Common Throughout State.

Partial List of Bee Flora of Maryland—*Continued.*

Common Name.	Scientific Name.	Date of Flowering.	Apicultural Value.	Distribution in Maryland.
Wild Carrot.	Daucus Carota.	July.	Slight value.	Common Throughout State.
Virginia Mint.	Koellis Virginiana.	July.	Contributory.	Common Throughout State.
Buttonbush.	Cephalanthus occidentalis.	July.	Frequently visited.	Frequent Throughout State.
Swamp Milkweed.	Asclepias incarnata.	July.	Contributory.	Frequent Throughout State.
Sundrops.	Oenothera fruticosa.	July.	Contributory.	Common Throughout State.
Peppermint.	Mentha piperita.	July and Aug.	Contributory.	Frequent Throughout State.
Sweet Clover.	Melilotus alba.	July to Sept.	Surplus.	Frequent Throughout State.
Water Hoarhound.	Lycopus rubellus.	August.	Contributory.	Not Common Throughout State.
Touch-me-not.	Impatiens biflora.	August.	Frequently visited.	Common Throughout State.
Mushmelon.	Cucumis melo.	Aug. and Sept.	Contributory.	Common Throughout State.
Indian Corn.	Zea Mays.	August.	Frequently visited.	Common Throughout State.
Great Ragweed.	Ambrosia trifida.	Aug. and Sept.	Contributory.	Common Throughout State.
Ragweed.	Ambrosia artemisiifoli.	August.	Contributory.	Common in Coastal Zone.
Asparagus.	Asparagus officinales.	Aug. and Sept.	Frequently visited.	Common Throughout State.
Spanish Needles.	Bidens bipinnate.	Aug. and Sept.	Frequently visited.	Common Throughout State.
Day Flower.	Commelina virginica.	August.	Contributory.	Common in Middle Zone.
Buckwheat.	Fagopyrum esculentum.	September.	Contributory.	Common Throughout State.
Goldenrod.	Solidago (Species).	Aug. and Sept.	Contributory.	Common Throughout State.
Aster.	Aster Puniceus and others.	Aug. and Sept.	Yields a light surplus.	Common Throughout State.
Red Clover.	Trifolium repens.	June to Aug.	Contributory.	Common Througout State.

Average Experience of Bee Keepers, Hives and Kind of Bees.

The average length of time during which the bee keepers who answered inquiries, had kept bees is 12 years. Of those reporting 38% had kept bees less than 5 years. This would indicate that we have a number of amateurs in the business. The great majority reported 8 and 10 years experience, while many reported keeping bees for 15 to 20 years. Of those reporting 68% kept Italian bees, which is a good sign, as it is believed that this is the most profitable and satisfactory race of bees to keep for Maryland conditions. It is not believed that all reporting Italian bees meant to report pure stock, but it shows a large per cent of good conditions. Moreover from this data it is found that about 80% of the bee keepers are using up-to-date frame hives. These conditions account for the good average of 30 pounds of honey per colony per year that these records show.

Bee Diseases in the State.

While funds have not been available to conduct a thorough investigation into the conditions of the apiaries of the State, yet through the cooperation of the Bureau of Entomology, we have been able to learn that the two diseases, European and American foul brood exist in several counties in the State. While these diseases will be discussed later on in this bulletin, it may be stated that these infectious diseases, where established, are disastrous to the apiary if steps are not taken to eradicate them.

There is no more dangerous menace to the industry than neglected apiaries infected by these diseases in a neighborhood where healthy bees are kept. Moreover, unless measures are adopted to prevent their spread, ignorance or neglect on the part of the owners, of apairies will certainly reduce, and perhaps annihilate an already neglected industry of the State.

The Needs of the Industry in Maryland.

Briefly it may be said that the majority of Maryland bee keepers need education in up-to-date methods of bee keeping. The remaining old box hives must be replaced by movable frame hives. The apiaries of the State should be inspected for the presence of infectious diseases and those keeping neglected hives should either be made to abolish them, or to give the bees attention and keep them in a healthy condition. Funds should be provided for instruction, investigation, and extension work by the State institutions, and legislation should be enacted such as now exists in twenty-six other states and territories for the protection and the promotion of the industry.

Maryland offers excellent natural advantages for the development of the beekeeping industry and it only remains for the beekeepers themselves to practise more up to date and scientific methods in the conduct of their apiaries and to secure the adoption of proper legislative measures to insure the State a more prominent rank in the production of bee products.

BEE KEEPING IN MARYLAND.

II. THE MANAGEMENT OF BEES.

By Arthur H. McCray, D. V. M.

Apicultural Assistant, Bureau of Entomology, U. S. Department of Agriculture.

Beekeeping for profit has within comparatively recent years assumed such exactness of methods compared with former times, that discussions of methods and appliances used in commercial bee keeping have followed quite naturally and are always in order for additional enlightenment. It is not the aim of this paper to discuss the merits of any particular system of management but to give simple working directions for the establishment and maintenance of a comparatively small apiary.

The methods to be used in bee keeping are determined to a certain extent by locality, and consequently vary for different sections of the country. While it is doubtless true that the importance of locality has been somewhat overestimated, it should not be ignored. This bulletin has been prepared particularly for the bee keepers of Maryland and the aim has been to make the directions and discussions herein given particularly applicable to Maryland conditions.

As a rule, one should not start bee keeping except in a small way. The uncertaintities of securing a honey crop are many and varied. As examples of the causes of failure, the following may be cited: the failure of the honey flora to secrete nectar; the inability of the bees to gather the nectar when secreted, owing to unfavorable weather conditions; the failure of the beginner to do the right thing at the right time; and last but not least the danger of losses from disease.

From the above it will not be surprising to learn that many disasters have occurred with beginners in bee keeping. It is, of course, all the more deplorable if the first investment has been too large. The beginner with a moderate investment, is more apt to recover from his early failures, than is one who has had too much at stake. Four or five hives are generally sufficient for the first season. These can be increased when the returns from the honey and wax are sufficient to pay for additional empty hives and other equipment. It is a good plan for the beginner to make the bees pay for the increased equipment, and produce some profit in addition. Probably nine out of ten, who make a failure of bee keeping, try to manage too many colonies without previous experience or knowledge.

From the small bee keeper develops very often the specialist bee keeper, and the aim should be to make better bee keepers of those already engaged in the industry rather than to increase the number. There is no reason, however, why every intelligent farmer should not keep a sufficient number of colonies of bees to furnish honey for his own use.

Bee keeping is usually carried on in conjunction with some other business. There is no reason, however, why it should not be made the sole means of livelihood. There are in the United States today, many men who devote all of their time to their bees, and find it a remunerative business.

With the improvement of the modern movable frame hive, together with the perfecting of systems of management, and a sufficient knowledge of the business, gained by study and experience, the opportunities of the specialist bee keeper, were never better than they are today.

The writer wishes to acknowledge his indebtedness to Dr. E. F. Phillips, in charge of Apiculture, Bureau of Entomology, U. S. Dept. of Agriculture, for valuable suggestions in the preparation of this bulletin and for the privilege of using many of the illustrations from Farmer's Bulletin, No. 447. Acknowledgements are also made to the A. I. Root Co., Medina, Ohio, for the use of cuts for figures 6, 12, 21, and 23.

BEE BEHAVIOR.

Every normal colony of bees in the active season consists of three kinds of individuals, (fig. 1.) the queen, a variable number of drones, and several thousand workers. The queen is the only fully developed female in the hive, and is the mother of all of the other bees. The drones often number several hundred and are present in the hive at or near swarming time in largest number. Their sole function is to mate with the virgin queen. Towards fall the drones are destroyed by the workers, usually by being forced from the hive, where they die of starvation. The workers constitute the largest part of the colony, and in a good sized colony number 40,000 to 70,000.

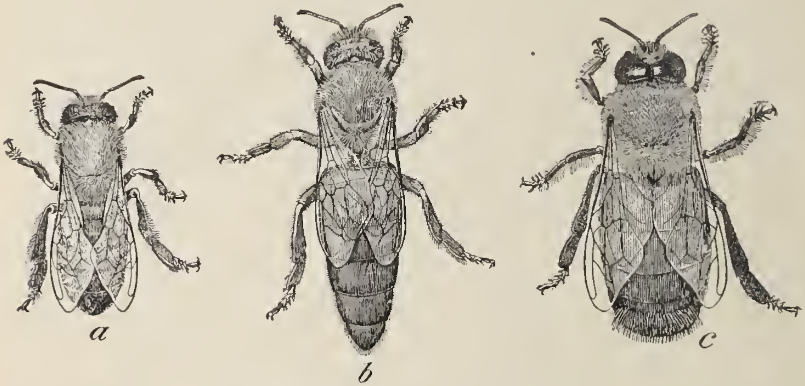

Fig. 1.—Worker, queen and drone.

The workers are sexually undeveloped females. They perform all the labor of secreting wax and building comb, feeding the young, protecting and cleaning the hive and gathering and storing honey and pollen.

The honey comb (fig. 2.) in which all honey and pollen is stored, and the young brood reared, is built by the worker bee from wax which is secreted from the under side of its abdomen, in the form of very small thin flakes. These flakes are manipulated by the mandibles of the bee and moulded into the various forms required in building the comb. The comb consists of hexagonal cells arranged on the two sides of a vertical septum, or mid-rib.

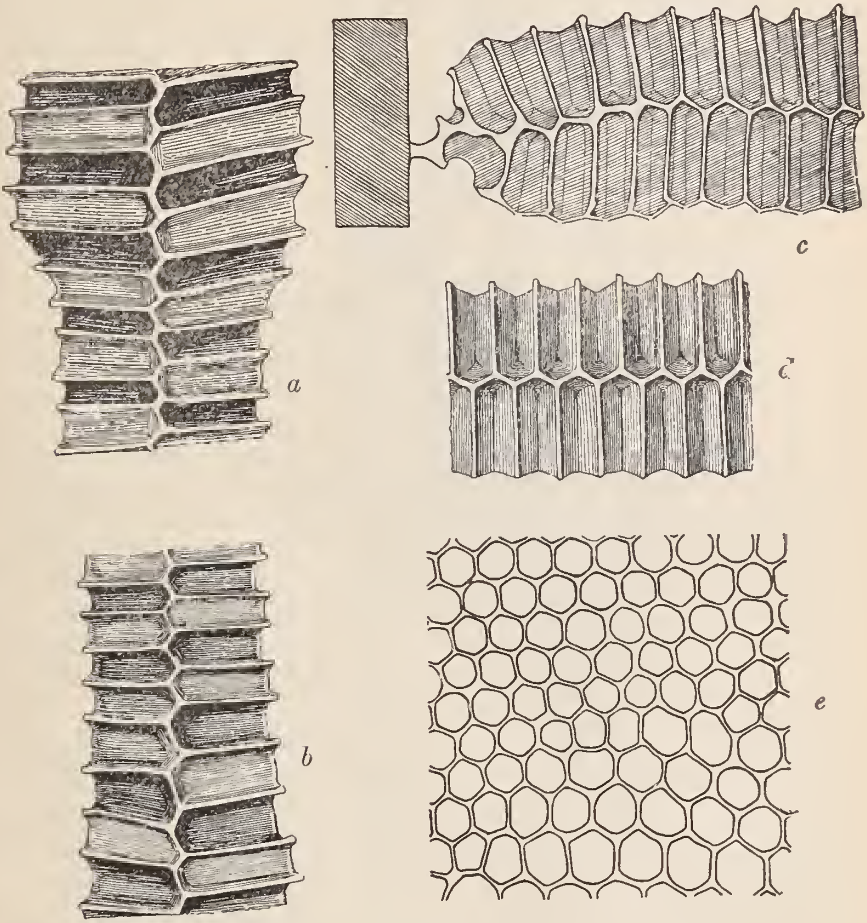

Fig. 2.—Comb architecture.

Two sizes of cells are easily recognizable, viz. that in which the worker bees are reared, which is 1/5 inch in diameter, and that in which the drones are reared, which is 1/4 inch in diameter. There are also irregular transition cells where these two sizes merge into each other. Any of the cells may be used for storage.

The eggs (fig. 3.) as laid by the queen are deposited on end at the bottom of the cell. In about three days the larvæ (fig. 3.) hatch, and are fed by being surrounded with liquid nourishment for about six days, when the cells are sealed over and the larvæ spin a cocoon and undergo a metamorphosis in which they are transformed into the adult bees, which emerge in about 21 days from the time the eggs are laid. The time of emergence varies for queens and drones. The period of the former is about 16 days, and of the latter about 24 days. The greatest number of eggs are laid by the queen during the season when nectar is being brought in, when all bee activity is at its height. Towards fall the queen lays fewer and fewer eggs, until in the months of September or October, often few eggs or little brood can be found in the combs. After a more or less inactive condition, including diminished brood-rearing through the cold of winter, the bees begin preparation for spring activity. Just at what time the queen begins active laying in the spring, varies considerably according to strength of colony, amount of stores, protection of the hive, etc.

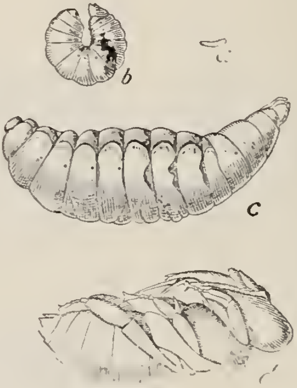

Fig. 3.—Egg larvae and pupae.

With the advent of the warm days of spring, and the opening of fruit bloom and other flowers, the colony rapidly increases in number of inhabitants, until the hive will no longer accommodate the increase and swarming is the result. The first swarm of the season, is accompanied by the old queen and a share of the worker bees. Previous to swarming, preparations are made by the bees for a new queen for the parent colony. This provision for the old parent colony consists in building queen cells, (fig. 4.) These are developed from young female larvæ by feeding them a specially prepared food. Normally the young queen does not emerge for several days after the swarm has issued with the old queen. If, however, the weather should be unfavorable, the young queen may emerge from the cell before the swarm with the old queen issues. Besides this first swarm accompanied by the old queen, there are often several smaller swarms, which issue after the first one. These after swarms are accompanied by one or more of the young virgin queens.

On or after the emerging of the first queen, the remaining queen cells are usually destroyed. This is not always done, however, and hence the issuing of several small swarms (after swarms), subsequent to the first. or prime swarm results. The swarm after issuing, if not taken care of by the bee keeper, seeks a home in some hollow tree or elsewhere. The parent colony acquires strength from the brood left by the old queen, and later from the progeny of the young queen, which emerges from one of the queens cells built under the swarming impulse. The young or virgin queen, before she becomes the mother of the colony, must first meet the drone or male bee and become mated. This takes place outside of the hive, and in flight and probably occurs only once in the lifetime of the queen. After mating, the young queen returns to the hive and in a few days takes up her duties as the mother of the colony. Eggs from which drones are hatched are not fertilized by the queen, i. e., they do not receive any spermatozoa, or male sex cells, as do the worker eggs. This is what is known as parthenogenetic development. A young queen on failing to mate with the drone will sometimes start egg laying. These hatch only drones. Sometimes when a colony is deprived of a queen for a long time, the worker bees, being undeveloped females, will start egg laying. Such eggs also hatch out drones. An old queen will sometimes lay eggs, which hatch drones only probably because of exhaustion of her supply of spermatozoa.

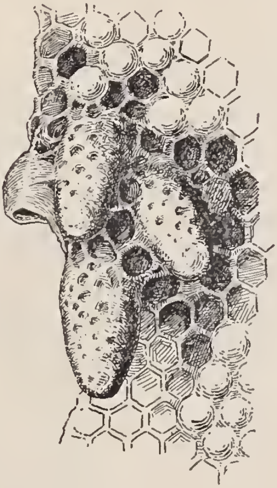

Fig. 4.—Queen cells.

This is only a very brief outline of some of the activities of the hive. A knowledge of bee behavior is essential to the successful handling of bees, and the bee keeper gradually acquires a few principles, which he unconsciously applies in working with the bees. Far too little is known of this subject and its application in the manipulations of the apiary.

EQUIPMENT OF THE APIARY.

Hives.

The kind of hive, providing it is of simple construction with movable frames, is not so important as is the method of handling it. Most of the honey produced in the country today, is taken from hives, that embody the main features of the Langstroth hive invented in 1851. This consists of a plain wooden box, holding eight or more frames hung from a rabbet cut in the inside of the wall of the hive near the top. The Langstroth frame is 9⅛ x 17⅝ inches. The modern hive is an improvement in that the wooden box has been much strengthened by the dovetail or interlocking corners (fig. 5.) Further improvement

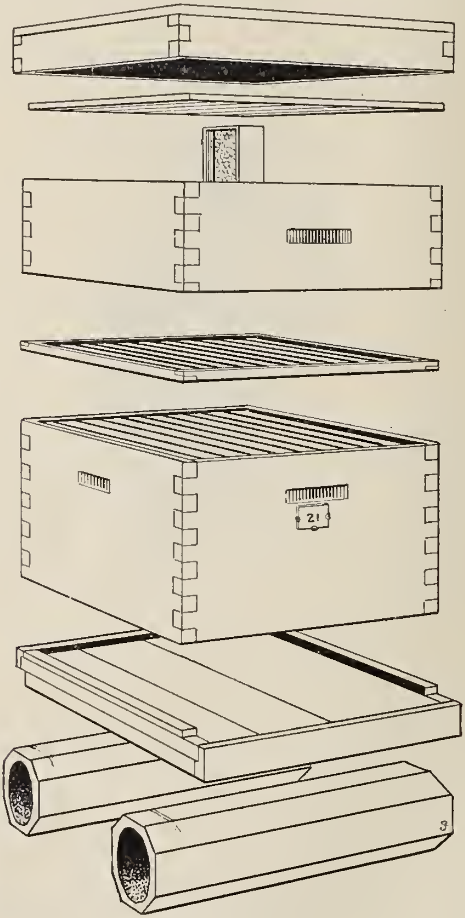

Fig. 5.—Ten frame hive with comb honey super, excluder and perforated zinc queen.

is secured by the use of a metal rabbet, which lessens the area of contact with the frames and so reduces the amount of propolis deposited between frame and rabbet. The eight and ten frame hives are in general use. Some use larger hives of twelve or fourteen frames, claiming that swarming is thereby reduced. Such hives are however, unwieldy to handle, and there are other efficient methods of controlling swarming.

Some bee keepers are advocating the use of a frame of about half the depth of the Langstroth. These are to be used as supers for the storing of the surplus, as well as for the brood chamber for the rearing of the young bees. Two or more bodies are required for the use of the queen as a brood chamber. The use of such shallow frames permits, to a large extent, of the handling of bodies rather than frames. The queen can often be found by smoking the bees from these shallow bodies, after which the operator can look up between the frames from the bottom and see the condition of the brood chambers as to stores and brood. (fig. 6.) It is believed that bee keepers can profitably try this style of hive. Whatever style of hive is used, the bottom board and cover should be detachable and not nailed fast to the hive body. Much information concerning hives and fixtures can be secured from catalogues of dealers in bee supplies.

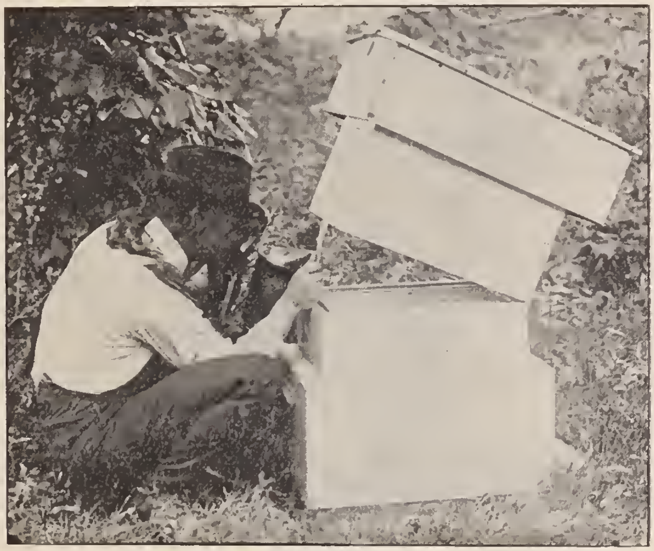

Fig. 6.—Looking up between frames.

Hive Stands.

All hives should be raised from the ground far enough to keep them from rotting. This may be accomplished by setting them on bricks, flat stones, etc. Six-sided hard burned tile (fig. 5.) placed crosswise at the front and rear of the hive have been found efficient. A cheap hive stand can be secured by hewing round sticks of wood on one or two sides, and using them in the same manner as the tile.

Tools and Other Apparatus.

Among the necessities of any apiary, large or small, are a good smoker (fig. 7.) to subdue the bees, and a veil, (fig. 8.), of some light material to protect the face. Some sort of tool for separating bodies and frames, and for scraping propolis and bits of wax from hives and fixtures is desirable. The ones figured have been found satisfactory (fig. 9.). Queen cages of which there are many kinds in use, will be found indispensable. Foundation fasteners, feeders, (figs. 16, 17, 18,

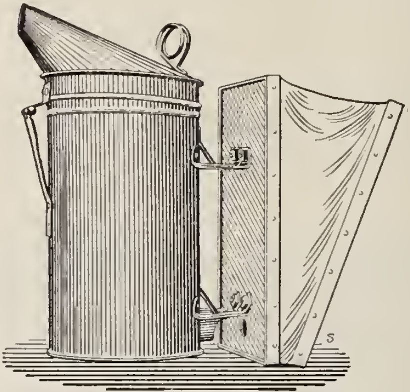
Fig. 7.—Smoker.

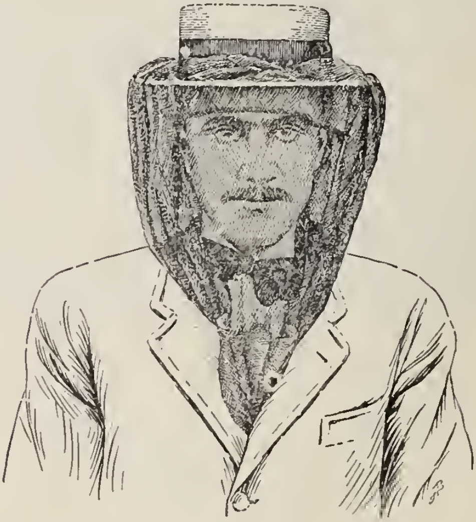
Fig. 8.—Veil.

19,) drone traps, (fig. 20.) and honey boards of perforated zinc (fig. 24.) are almost equally as indispensable, not to mention such other desirable apparatus as division boards, swarm catchers, bee

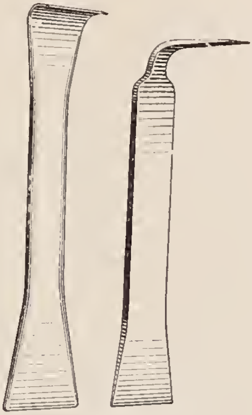

Fig. 9.—Tools.

brushes, (fig. 10.), wax extractors, etc., etc. All of this apparatus is amply described and figured in catalogues of supply dealers.

Honey House and Shop.

The honey house should be quite near to the apiary for convenience in handling supers full of honey when taking off the crop. It is not desired to say a great deal concerning a honey house, except to urge

Fig. 10.—Bee brush.

the desirability of every bee keeper, providing some such place where empty hive bodies and supers and all other tools and apparatus can be kept and easily found when wanted. The section honey must be scraped free of propolis and packed, and the extracted honey thrown from the combs, and it is better to have a small building especially for this purpose. The honey house need not be expensive, and it will certainly facilitate the work of the apiary. A shop where hives and fixtures can be put together, and where other work requiring the use of tools can be performed, is indispensable. The honey house can be made large enough for this purpose.

BEES.

Usually the cheapest way for the beginner to acquire bees for the apiary, is to purchase a few colonies near home. There are often black bees near at hand in box hives, or antiquated frame hives, which can usually be purchased at small cost. These can be bought in the fall and wintered. It is better however, to purchase in the spring, and reduce chances of winter loss. These are to be transferred when fruit bloom opens. The race of bees purchased matters little as the bee keeper can introduce a queen of whatever race of bees he desires in the spring, and soon the whole colony will consist of the offspring of the newly introduced queen.

This is due to the fact that during the height of the honey gathering season, the tasks of the worker bees are so arduous that their life period is quite short, and as they die their place is taken by the progeny of the recently introduced queen. If bees cannot be secured near at hand then one or more nuclei (small colonies) of two or three frames each can be purchased of a dealer. These can sometimes be increased to several full sized colonies during the course of the season.

Of the several races of bees maintained by bee keepers at the present time, the beginner will probably find the Italians most satisfactory. This race is the equal of any in nectar gathering ability and actively resists the ravages of wax moths. Italian bees are gentle and easily handled, and they have received far more attention from breeders than any other race. This is not saying however, that other races are not worthy of equal attention with a view to improvement. There are on the market today so called Red Clover queens, whose progeny are supposed by some to possess tongues of sufficient length to reach the nectar in the blossom of the red clover plant. While these bees are usually good honey gatherers, the results secured by their use, would scarcely warrant such a descriptive term as "long tongued" or "Red Clover" bees. The Italian race of bees has also been bred for color, so that three, four, and five, yellow-banded strains are now in use. It must be borne in mind, however, that color marking is of secondary importance, and that honey gathering proclivity is the first consideration. Utility should not be sacrificed for ornament.

Caucasians have been used to some extent, perhaps largely because of their gentleness and ease of handling. They are good honey gatherers and quite prolific. The queens are however dark and sometimes small, and hence difficult to locate on the combs. This race also collects great quantities of propolis, and builds a large amount of brace and burr combs, factors which are not conducive to easy and rapid handling of frames.

The Cyprians have been almost universally ruled out because of their fierce stinging proclivities.

The Carniolians are very gentle, but swarm excessively and are not much used.

Other known but little used races are the Banat, "Holy land," Egyptian and Punic. Of these four last named, the Banat is most used and is looked upon with favor by some breeders and honey producers.

The black or German bee was the first race introduced into this country, and is still abundant usually as a cross with other races. The black bee is not desirable and is being gradually supplanted by other and more desirable races.

THE APIARY: ITS LOCATION AND SIZE.

While there are certain ideal sites for the location of the apiary, which should be utilized if possible, yet bees can be kept in a great many places which do not conform to ideal surroundings. A slope gently inclining to the south and east is very desirable, although any plot of ground that has good drainage, so that water does not stand on it, is good. The slope to the south and east secures protection against cold winds from the north and west, although this advantage can be as well and even better attained, sometimes, by other barriers, such as a grove or fruit orchard. Buildings of some kind can often be made to serve this purpose, as the honey house and shop.

The hives should not be too near walks or drives, owing to danger from stings. This is particularly applicable if horses that are perspiring are likely to be brought near such driveways.

It is considered best to face the entrance of the hives south or east, or somewhere between these two directions. This will give the bees the early morning sun and start them gathering nectar early in the day. While it is desirable to have a certain amount of sun, particularly in the early part of the day, this may be a source of discomfort and actual loss if hives are unshaded at the hottest part of the day. The midday and afternoon sun when beating down on unprotected hives may be so severe as to melt down the combs within the hive. The result of such a disaster is obvious. Perhaps the ideal location as far as providing shade is concerned, is under trees that have the branches high enough not to interfere with easy movements of the operator when attending to the hives. The comfort of the bee keeper is to be considered as well as the welfare of the bees. One is more apt to give the bees the attention they need, if the work can be done in the shade, rather than under the rays of the sun at the most heated part of the day.

The hives should be level from side to side in order that the combs may be built straight. If the hives were inclined to one side, it would result in the newly drawn comb, being swung from the top bar of one frame and attached to the bottom bar of the frame adjacent, since comb building progresses from above downward. The hives should, however, slope downward from the rear to the front. This will cause any rain, which may beat in and any moisture which may condense on the inside of the hive to run out at the entrance.

The hives can be arranged to suit the convenience of the operator in manipulation. Ample space should be allowed for ease of movement. A good arrangement consists in setting the hives in rows. (fig. 11.) A line may be used to get the rows straight.

As to the covering of the ground, whether bare or sod, it is believed that grass is much more preferable as it facilitates the ease and pleasure of working in the apiary. No grass or weeds, however, should be allowed to grow up at the entrance of the hive. A lawn mower can be used to good advantage in keeping the grounds in and around the apiary in good condition.

As before said, the above are more or less ideal conditions. Bees can be kept in a great many places with profit that are far from conforming to the above conditions. City people even manage to keep bees by setting them out on the roof or a back porch where the line of flight is clear so that there is no danger of interfering with neighbors.

The size of the apaiary will depend on various factors, chief among which will be the time and inclination of the bee keeper, and the natural flora present, from which the bees may gather nectar. The number of colonies of bees which a given locality will support will vary, and the beginner as he gradually increases his colonies from year to year, must determine the point at which he must cease increasing at the home yard and begin the establishment of out apiaries.

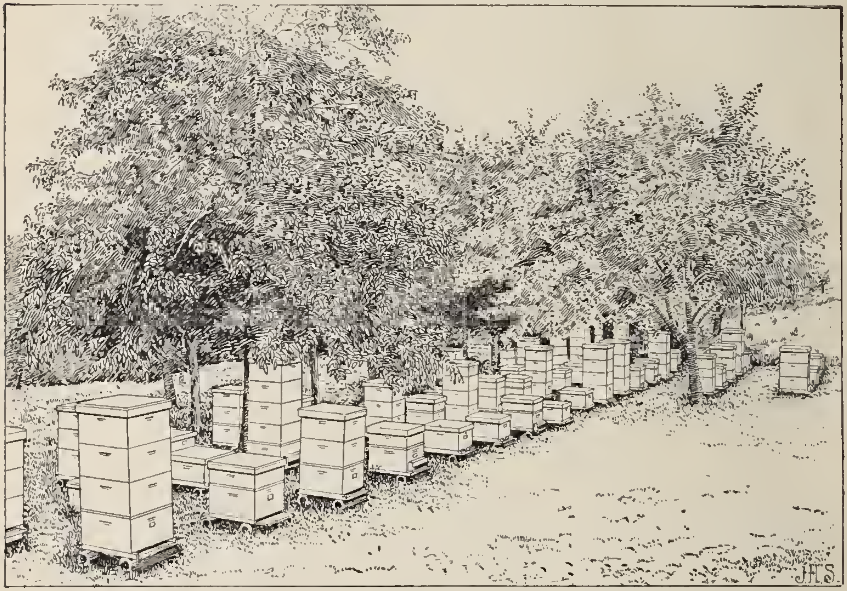

Fig. 11.—An apiary in Maryland.

It is believed that it is best to err on the side of too few colonies, rather than too many, although there is some reason for believing that the number of colonies which may be kept in one apiary has often been underestimated.

If the bee keeper is not yet willing to give all of his time to the bees, then the home yard may be crowded so that 100 or 125 colonies may be maintained there under Maryland conditions. But if practically all of the time is to be devoted to the bees, it might often be better to establish out apiaries maintaining only about 50 colonies in a yard.

The distance to which bees will fly for nectar has been variously estimated at from 1 to 3 miles depending on the amount of nectar near at hand, or limitation of range due to some natural barrier as a body of water, mountain, etc.

The keeping of bees all in one large apiary has the advantage and certainly is to be practiced whenever the resources of the surrounding country will warrant it. With only one yard, there is economy in providing honey houses, tools, and often in transporting the crop after harvesting.

TRANSFERRING: GENERAL MANIPULATIONS.

The first attempt in the handling of bees will probably be the transferring of the colony or colonies purchased in the old box or antiquated frame hives to modern movable frame hives. It will be assumed in giving directions for transferring, that little or nothing is known of the handling of bees and directions for general manipulations will be incorporated in the directions for transferring rather than devoting a separate paragraph to this subject.

Beginners should always protect the fact with a veil and have the smoker within easy reach. The old hive from which the bees are to be transferred is lifted from the stand and the new hive body with frames, containing full sheets of foundation is set in its place. Full sheets of foundation of worker size cell base will insure straight even frames of worker cells. This should be strengthened by wiring. Avoid rough handling, and quick movements, especially if the bees have not been subdued by the use of the smoker. After bees have been partly subdued by the smoke, the hive may sometimes be jarred about to advantage causing the bees to further gorge themselves with honey until they become quite tractable. If the old hive is a plain box without frames, it must be inverted. If the bottom is nailed fast, it or one side must be removed. Set a tightly fitting box over the exposed side, and by beating on the old hive, (fig. 12.), the bees are made to enter the empty box, after which it can be removed and the bees shaken out at the entrance of the new hive. The bees should not be shaken on the ground, but provided with a runway consisting of a board the width of the hive or greater. This should slope gently upward from the ground to the hive entrance. As the bees are shaken onto this board, the queen can often be seen entering with the other bees. The operation will not be successful unless the queen enters the new hive, since the bees will not remain without the queen even though they all pass into the new hive. The bees must be repeatedly drummed from the old hive until the queen is secured. The bees will not remain longer than a half hour or so in the new hive without the queen and this will serve as an indication to the operator whether he will need to repeat the drumming. The cover should now be lifted from the new hive to note whether the frames are properly spaced. This only applies to frames without a self-spacing device. It is probably better for the inexperienced bee keeper to have frames which will space themselves when forced together one against the other. These are termed self-spacing frames.

The old hive should now be turned right side up and moved some distance away. Allow it to remain here for 21 days, when all of the brood will have hatched and emerged as young bees. These are to be drummed as before and united with the new hive, first, thoroughly smoking both hives to prevent fighting. If the first or old queen is the one desired, the entrance of the new hive should have a piece of queen excluding zinc fastened at the entrance to exclude the young queens. The plan generally followed, however, is to disregard the young queens, by allowing them to enter and the bees to determine the choice of queen. Old combs will usually be found to be so crooked, or so old and black, that they are fit only to be cut out and rendered into wax. They can be saved, however, by cutting out the more regular portions and fitting them into empty frames, securing them by passing cord or rubber bands around the frame, after

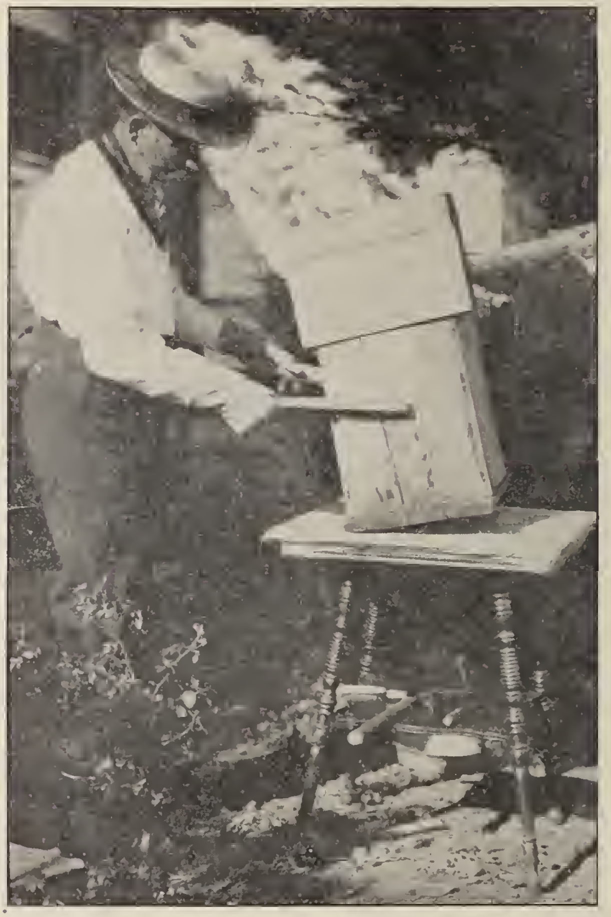

Fig. 12.—Drumming bees from old hive.

which they may be used for hiving swarms or for the storage of honey for extracting. Also the old combs with brood and stores is sometimes cut out and fitted into frames as above described, at the time of the first transferring, instead of setting the old box hive away for 21 days. These frames are then set in the new hive, the bees are shaken in and the transferring is completed at one operation. It is believed that the first described method will prove most satisfactory.

The opening of fruit bloom in the spring is the best time of the year for transferring, although it can be done at any time that nectar is being gathered. It can even be done when there is nothing coming in from the field, provided the bees are fed daily after transferring.

It is best to select a warm, bright day when the bees are flying freely as they can be much more easily handled then. On cool, cloudy days and early and late in the day, bees are usually much more difficult to handle, and are more inclined to sting.

The bees in the new hive should be examined from time to time to determine progress made in comb-building, and in the laying of eggs and rearing of brood.

One should learn from the first how to open a hive and examine frames without unduly exciting the bees. Always stand at one side, out of the line of flight of the bees, (never in front of the hive). First use the smoker at the entrance, then quietly remove the cover, so that it does not come away with a jar. As the cover is lifted, gently blow some smoke over the tops of the frames, after which they can be removed one at a time. If at any time the bees show an inclination to sting while the colony is being manipulated, more smoke may be blown down between the frames. In examining frames, always hold the comb in a vertical position, otherwise it is apt to be broken from its attachments owing to the weight of honey and brood. As the frame is lifted from the hive by the ends of the top bar, one side will be exposed to view. To observe the opposite side, lift the frame as shown by the illustration, until the long instead of the short axis is perpendicular, (fig. 13.) and rotate the frame as a door is swung on its hinges, using the top bar as the axis (fig. 14.) The frame can then be lowered with the top bar below, (fig. 15.) This whole manipulation is easily acquired and if the precaution above mentioned of preserving the face of the comb perpendicular instead of flat wise to the ground is observed, no danger of the comb breaking in the middle will result. As the frames are being removed from the hive, the first one or two can be

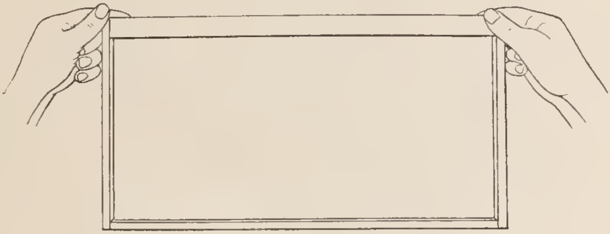

Fig. 13.—Handling frame 1st position.

leaned against the outside of the hive. This will permit of space for easy movement in handling the remaining frames, which can be placed to one side as they are examined in succession. After the last frame has been examined, the frames can be lifted over to position and the one or two leaning against the outside of the hive returned to their place.

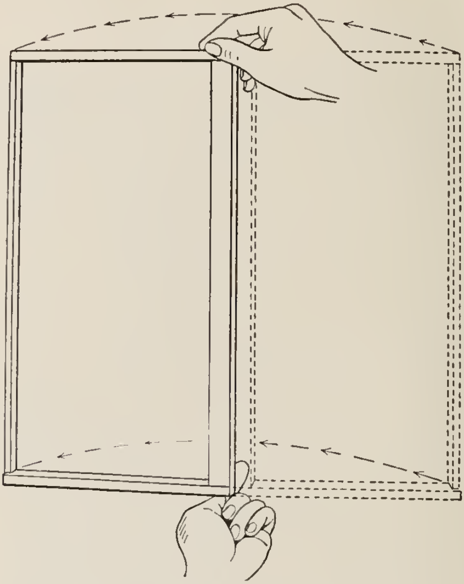

Fig. 14.—Handling frame 2nd position.

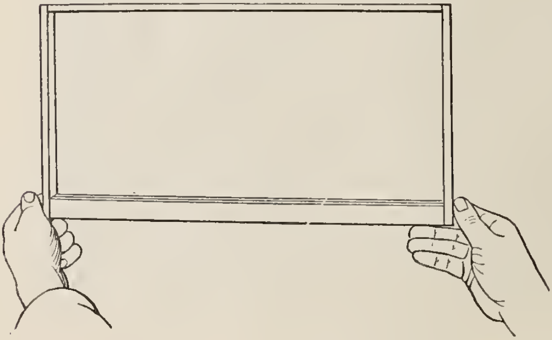

Fig. 15.—Handling frame 3rd position.

UNITING.

It will be desirable at times to unite colonies for various reasons. While some of these reasons are sufficient to justify the operation, yet owing to the difficulty of successful uniting it should usually be resorted to only when the weakened colony can not be built up by feeding. Colonies that are queenless quite early in spring or late in fall can be profitably united. Uniting can be done by setting the colony to be united over the one to which it is to be united. Another method is to lift the frames out separately and shake the bees at the entrance of the colony selected to receive them. In all uniting operations smoke all colonies thoroughly, and cage the queen to be saved for two or three days afterwards, to prevent her being killed by the strange bees.

SPRING MANAGEMENT.

In order to secure the available nectar from the flowers it is necessary to have a large force of bees of the right age in the colony when the honey flow begins. Colonies with bees in sufficient number and of proper age are assured only when given proper attention by the bee keeper. Various factors operate to reduce the strength of the colony through the winter and early spring. So called "spring dwindling", results when the bees are allowed to pass through the winter with too large a force of old bees. These die very rapidly in the spring so that the brood does not emerge rapidly enough to maintain the colony strength. An induced prolongation of brood rearing in the fall will often prevent this trouble. The amount and kind of stores which are available to the bees, through the winter and early spring months, determine largely their condition for the honey harvest. The stores collected in the fall are not always suitable for maintaining the bees in the best of condition during the winter. The secretions deposited by plant lice on foliage and collected by bees is unfit for winter food. This is popularly known as honey dew honey. Other products such as juice from various fruits, or thin improperly ripened nectar, to the exclusion of good well ripened honey, may result in positive injury to the bees, causing what is known as "dysentery." This disease is manifested by the bees spotting the outside and inside of the hives including combs, with a yellow discharge. This trouble usually disappears after a day sufficiently warm to permit of a cleansing flight by the bees.

Feeding.

Enough stores may be provided in the fall to maintain the bees until the beginning of the honey flow without giving them additional supplies.

Very often, however, good results are secured by stimulative feeding, in the spring. This consists in giving each colony daily a small quantity of feed. This feed may be made by mixing granulated sugar and water, using about two or three parts water to one part sugar. This seems to act much as a flow when honey is daily brought into the hive. This results in early brood-rearing, securing the large field force required to gather the nectar when the flow begins. Of the feeders used for early spring feeding the division board feeder (fig. 16.) will probably be most satisfactory, as it is lowered into the hive just as a frame, and consequently receives warmth from the cluster. The

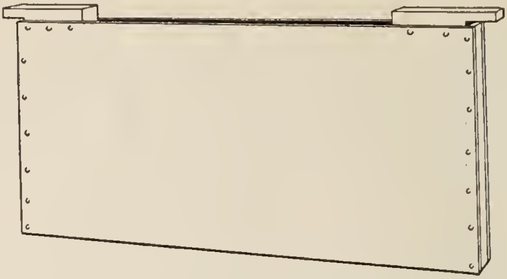

Fig. 16.—Division board feeder.

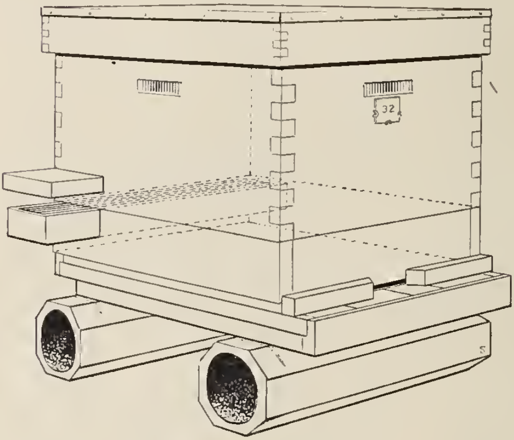

Fig. 17.—Alexander feeder.

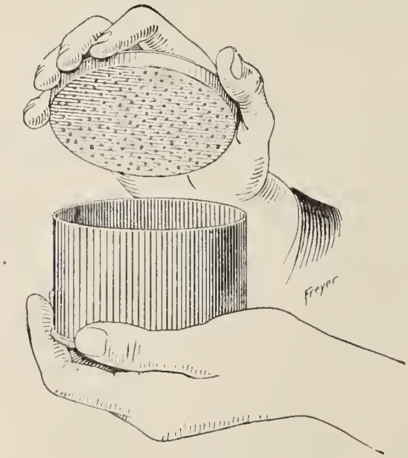

Fig. 18.—Pepper-box feeder.

Alexander feeder fitted in a wooden collar at the rear of the hive may be used. (fig. 17.) This has the advantage of not requiring exposure of the colony in replenishing the feeder. The pepper box feeder consists of a metal cylindrical box, with a perforated cover and is inverted over the frames in an empty super. (fig. 18.) This can be used for spring feeding if the super is packed with a chaff cushion or blankets. A good feeder can be made by setting a pan filled with syrup in an empty super. (fig. 19.) Stimulative feeding in the spring will usually yield large dividends in added returns at the time of harvesting. The best time in the day for feeding is towards evening, when the bees will not have time to start robbing, which often results after feeding, particularly if syrup has been carelessly scattered about.

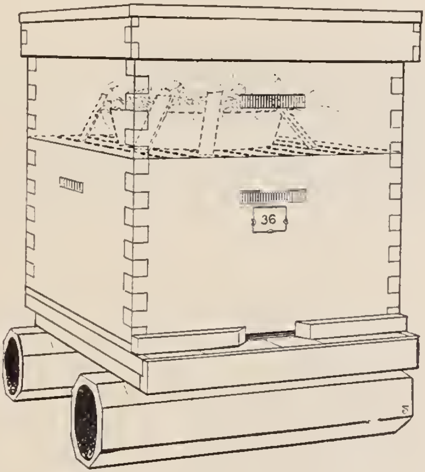

Fig. 19.—Pan feeder.

There will always be colonies that contain a large amount of brood compared with others. Frames of brood can be taken from these strong colonies, to aid the weaker ones. By judicious manipulation of frames in this manner, all colonies can often be increased to about uniform strength for the honey harvest.

Colonies can also often be advantageously stimulated to increased brood-rearing by resorting to what is termed "spreading the brood." This consists in inserting an empty comb between two frames already containing brood. The bees attempt to cover the brood thus enlarging the cluster, and the queen will lay in the empty frame. This procedure should not be undertaken while the weather is unsettled, because a few cold days following a warm period will result in the bees contracting the cluster and the brood which has been lifted to one side is left outside of the cluster where it perishes.

There will always be colonies that appear in the apiary in spring in a weakened condition. Such colonies should be carefully fed and contracted so that they will not be forced to attempt to keep a whole brood chamber warm. Such contraction of the brood chamber can be accomplished by leaving only a sufficient number of frames as will enable the bees to form a compact cluster, filling the whole available space. The space at the side of the hive should be filled in with a chaff cushion, or a dummy packed with sawdust or some similar materials. The entrance also should be sufficiently contracted.

It is believed that weak colonies are best taken care of by being built up to strong colonies by feeding and contracting. However, if for any reason this is not desirable, the weak colony may be united to a stronger colony by being set over it. Smoke both colonies first, and cage the queen desired, if each colony has a queen. This plan can be used to save a colony that is queenless in early spring.

SWARMING.

Stimulative feeding and other operations for increasing the strength of colonies tend to bring on swarming as the season progresses. Other factors influencing the time of swarming are locality and seasonal variation. The causes operating to induce swarming, are not sufficiently known. Reasons that seem to be sufficient to explain swarming at one time are insufficient at other times. It would seem that if the bees increase to such an extent that the colony becomes crowded and overheated swarming is very often apt to result particularly if a honey flow is on.

Reference has been made previously to the use of large hives as a means of controlling swarming. Lack of sufficient ventilation as a natural accompaniment of an overcrowded condition of the colony, may be partly responsible for the issuance of a swarm. Swarming can be controlled, but cannot be prevented.

Swarming may be profitable by yielding returns in an increase in the number of colonies if this is desired. On the other hand it may be a means of actual loss to the bee keeper, in reducing the honey yield. This will be understood when it is realized that a colony that divides its force by swarming in the height of the honey flow, can be made to yield only a part of what it would have, had it not swarmed. Moreover there is the additional labor required in taking care of the swarm which is a considerable item.

Care of Swarms.

One of the first steps to be taken in swarm management is that of clipping the wings of the queen. This can be done by holding the queen between the thumb and the index finger of the left hand, and cutting off the wings of one side with a sharp pair of scissors. Some think that the queen is better able to maintain her balance on the combs if the wings are cut on both sides. When the swarm issues, the queen being unable to fly is left behind, and is usually found crawling around near the hive entrance. Because of the absence of the queen, the bees will return in a few minutes, unless by chance they have a virgin queen. The old hive is now moved to one side and a new one containing full sheets of foundation is put in its place. The queen is put in a wire cloth cage and placed at the entrance. As the bees return on finding the queen absent from the cluster, the cage is opened and the queen allowed to enter with the other bees. The returning field bees from the old hive which has been set to one side will also return in greater number to the new hive on the old stand. If there were any surplus honey supers or extracting frames on the old hive they should now be transferred to the new hive, putting a piece of queen excluding zinc, (fig. 24.) between brood chamber and surplus honey to keep the queen below.

If it is not desired to clip the wings of the queen an Alley's queen and drone trap may be placed at the entrance, (fig. 20.) As the swarm issues the queen is engaged in the trap where she may be found and the swarm is disposed of as above described.

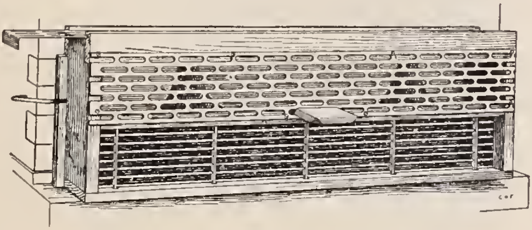

Fig. 20.—Alley's queen and drone trap.

When the swarm is allowed to issue without securing the queen it usually clusters on a branch of a tree near at hand, where it remains for a varying period of time. In this case the branch can be cut away and the bees carried where they are wanted, or the hive can be brought and held under the branch, which is then jarred, causing the bees to fall into the hive held to receive them.

Swarm Control.

While the clipping of the queen's wings, and other methods of preventing the queen from joining the swarm are means of controlling the swarm after it issues, they are not attempts to curb the swarming impulse. The need of ventilation and addition of supers, etc., in preventing overcrowding have been mentioned. A large force of bees is only desirable as the rush of the honey flow comes on, for after this they become consumers, not producers. Moreover it is possible that if eggs are laid and brood reared, up to and including the time of the honey harvest, excessive swarming may result where otherwise it might have been lessened and largely prevented by restraint of the queen. This can be done either by removing or by caging the queen for a time. As a rule, however, the queen should not be too much restrained, and the excess of brood in the hive can often be used to advantage in strengthening weak colonies.

Artificial Swarming.

Instead of waiting for the bees to swarm of their own accord, the bee keeper may practice artificial swarming or what is termed "shook swarming." When properly done, this may be made an efficient means of controlling natural swarming. The procedure is as follows: Watch all colonies for the first preparations for swarming as manifested by the starting of queen cells. As soon as this is noticed, shake most of the bees from the combs into a new hive which has been placed on the old stand. The new hive may be provided with either starters or full sheets of foundation as desired. The full sheets are probably better as a greater amount of worker comb is insured, while if starters are used there is in a great many cases more or less undesirable drone comb built. After shaking, the old hive with brood and the few bees that remain is moved to a new location, and allowed to increase again to a full colony or the bees may be later added to the shaken swarm. Bees thus shaken into a new hive sometimes leave. This can be prevented by placing a trap at the entrance to retain the queen. Artificial swarming should not be practiced too early as the bees are apt to swarm naturally later.

SECURING THE HARVEST.

Preparation.

Emphasis has been laid on the necessity of securing a large force of bees ready to gather the nectar, when the flow comes on. It is no doubt true, that for a varying period after emerging, the young bees engage in duties on the inside of the hive before going into the field. This period is usually about two weeks. By adding this time to the three weeks required for the development from egg to the emerged insect, it would seem that it requires usually about five weeks to develop a field bee. For most of the State of Maryland the fruit bloom and other early flowers is usually sufficient to be of decided aid in stimulating brood rearing for the harvest to be secured later from white clover. Stimulative feeding will no doubt prove profitable especially in those years when fruit bloom honey is scarce or entirely lacking.

Extracted Honey.

Honey may be secured either as extracted or comb honey. It is doubtless true that the bee keepers of Maryland, have given far too little attention in the past to the production of extracted honey. It is not intended to include under the term extracted honey, the product secured by mashing combs, honey, pollen and perhaps an occasional cell containing brood into one mass and straining the whole through cloth.

Extracted honey is secured from frames of comb that have been allowed to remain on the hive long enough to properly ripen. The cappings are removed from the comb by a sharp knife, after which the frame is put in an extractor (fig. 21.) and revolved rapidly enough to throw the honey from the cells. The frames of comb are then returned to the hive to be filled again by the bees. The bees consume honey in order to be able to secrete wax for comb building. The amount of honey thus required has been variously estimated. It has been stated that for every pound of wax secreted the bees consume 15 to 20 pounds of honey. Certainly there is economy indicated in the production of extracted honey where the combs are used over and over again.

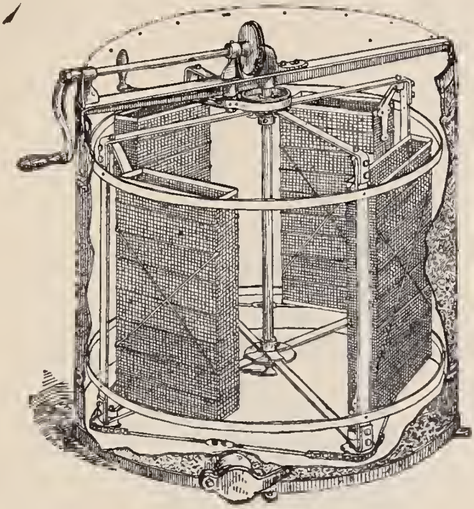

Fig. 21.—Extractor.

In extracting, the cappings are removed with knives especially made for this purpose. (Fig. 22.) A butcher's knife is used by some and found to be satisfactory. Two or more knives are needed, the one not in immediate use being immersed in hot water to keep it clean and warm.

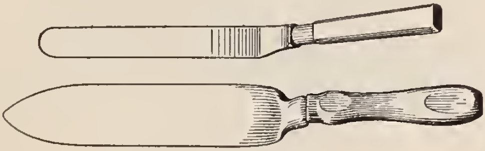

Fig. 22.—Uncapping knives.

Care must be taken that the honey is properly ripened in the hive before extracting, otherwise it may ferment. The care of honey after extracting cannot be given in detail here, but suffice it to say that it is not usually bottled or otherwise sealed at once. The receptacles in which it is to be marketed may be left uncovered, and placed in a vessel containing hot water, using care that the flavor is not destroyed by too high a temperature. A temperature of 160 degrees F. but not higher should be maintained for some time, after which the receptacles are sealed at once, before the honey cools. Extracted honey that has granulated may be liquified in the same way using the same care in avoiding a temperature above 160 degrees F.

Frames that are of the same dimensions as the brood chamber are usually used as extracting frames. An eight or ten frame body of such frames filled solid with honey is, however, rather unwieldy, and it is believed that a frame not so deep can be used to good advantage owing to ease of handling when the honey is removed for extracting.

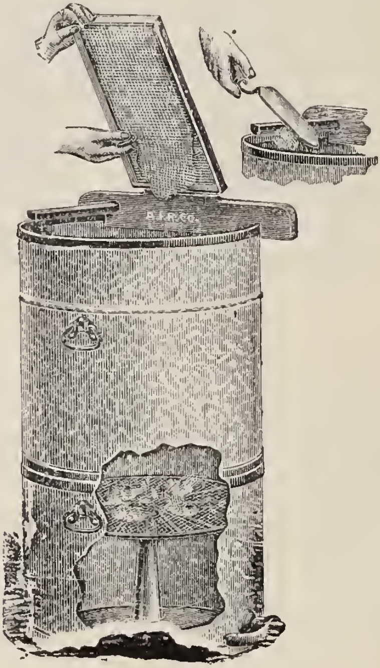

Fig. 23.—Uncapping can.

Comb Honey.

Not every locality presents conditions suitable for the production of comb honey. This product of the hive must be stored rapidly to produce an article which will command a good price on the market. Comb honey stored during a honey flow of several weeks is usually travel stained, propolized and otherwise soiled and the combs are often irregular so that it is no longer an attractive article. The long honey flow is more suitable for the production of extracted honey.

Localities in which the flora yields only a more or less dark grade of honey are not suitable for the production of comb honey, since the appearance of comb honey is an important factor in its profitable marketing. Pound for pound the best grade of comb honey is worth about five cents more than the best grade of extracted. It should be borne in mind, however, that the yield per colony of comb honey is less than the yield of extracted honey. The demands of the available market will, however, be an important factor in determining the kind of product. The important thing to know, however, is that any locality that will yield nectar at all is adapted to extracted honey production, while the profitable production of comb honey requires peculiar conditions and unless these are present it certainly will not be wise to attempt it.

Comb honey is produced and marketed in small wooden frames known as sections. The sections which are in use vary somewhat as to dimensions, but all approximate more or less closely a pound in weight when filled. Sections are arranged in rows in the super and fit very closely in order not to leave open space for the depositing of propolis. The rows of sections are separated by a wooden slat or separator of which there are several kinds in use. The bees are enabled to pass from the brood chamber to the sections by one of two methods. Either the edges of the section are cut away to provide space between it and the separator, or the separator may have cleats attached, which coincide with the edge of the section. In addition the separator may be made up of separate slats much after the manner of a board fence, allowing passage for the bees from section to section.

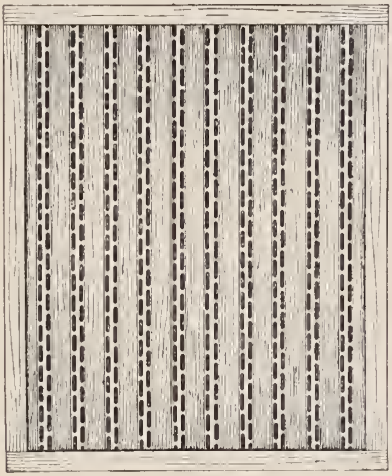

Fig. 24.—Zinc excluder.

Either narrow strips or full sheets of foundation may be used in the sections. Sections should be folded, foundation put in, and supers arranged with sections in advance of the season in order that there may be no delay in getting the surplus receptacles on the hives when the rush of the honey flow comes on. Perhaps the largest amount of comb honey produced in Maryland comes from the white clover flow which sometimes lasts only a short time. From this it will be understood how imperative it is to have a large force of worker bees at the right time.

The queen should be kept below by the use of a sheet of perforated zinc. (Fig. 24.). The treatment of swarms has been described under the topic "swarming." Add supers as they are needed, so that crowding does not result. After the first super is about half filled with honey, lift it up and put the second super under it. This insures comb building in the sections, which can later be filled with honey. It takes abundant nectar secretion for the bees to secrete wax, hence the comb in the sections should be started early in the flow. If there is prospect of the honey flow coming to an end soon, it may be necessary to change supers again, in order to get the first sections filled out in first class condition. It may be desirable even to remove some of the supers at this time or a little later as the flow draws to a close.

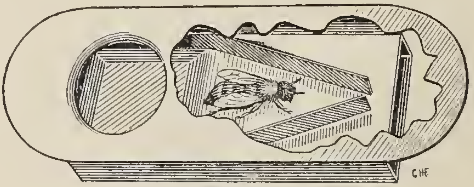

Fig. 25.—Spring bee escape.

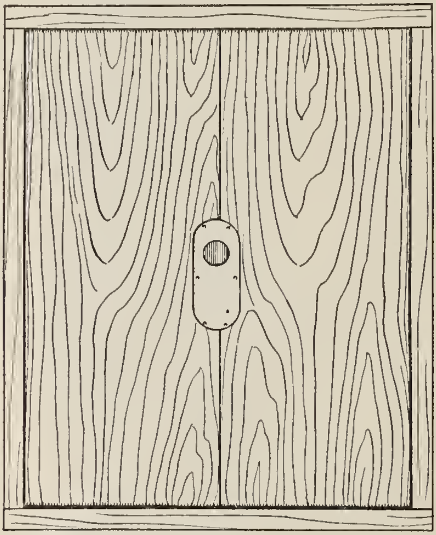

Fig. 26.—Bee escape in board.

Comb honey production requires skillful manipulation of supers which the bee keeper acquires only by study and practice. Sections not filled and capped sufficiently for the market, should be retained for use as "bait" sections, for next year. These are put at the sides of the super where owing to the low temperature the bees are slow to build comb and store honey. Comb honey should not be allowed to remain in the hive long after capping owing to liability of the bees soiling the face of the section with propolis and old wax. Sections soiled by the bees in this manner are described as "travel stained." Comb honey is easily removed by the use of a bee escape which clears the super of bees. (Figs. 25 and 26.)

MARKETING THE CROP.

Judicious marketing of the crop may often largely measure the profits of the bee keeper. The securing of a crop of honey is only partly indicative of the success to be attained. Many bee keepers, especially those who keep only a few colonies, are too often inclined to sell at too low a figure. The aggregate of the output, often of an inferior quality, of such indifferent bee keepers, frequently makes it impossible for others to profitably market a good article. It is the duty of the State and County Bee Keepers Association to institute and maintain a vigorous campaign for the education of the bee keepers of the State in profitable methods of marketing.

Carefully grade all honey so that each lot is of uniform quality; do not attempt to mix a few soiled sections with a No. 1 article on the assumption that the first class article will aid the sale of a second or third grade. Carefully scrape the wood of sections free of propolis and bits of wax, and pack in the regulation shipping case. Grading rules for comb honey are published in all of the bee journals. The style and size of package for extracted honey will depend on the demands of the market in which the bee keeper disposes of his product. A fancy article in a neatly labeled glass package will more than repay the extra cost, in added sales and increased price obtained.

THE PRODUCTION OF WAX.

The saving of the wax that accumulates about the apiary may add not a little to the income of the bee keeper. This is especially true if much extracted honey is produced owing to the accumulated cappings and scrapings from the frames. There are a number of wax presses of varying degrees of efficiency for sale by supply dealers. The various apparatus and methods used in wax extraction are described in books and journals relating to bee keeping. The subject is too extensive to be discussed in the limited space of this bulletin.

WINTERING.

The wintering of bees in Maryland presents so few difficulties that a discussion of this subject does not seem justifiable. Colonies that go into winter quarters strong in bees and with properly ripened and sufficient stores, will usually pass through the winter in good condition.

DISEASES.

Of the diseases which attack bees the greatest losses arise from the two infectious diseases of the young brood, viz., American Foul Brood and European Foul Brood.

American Foul Brood is characterized by a ropiness of the affected brood, manifested by thrusting a wooden splinter into the dead brood and removing it. In some cases the ropy mass can be drawn out to the extent of 3 or 4 or more inches. Later this ropy mass dries and forms a dark brown scale on the lower cell wall usually adhering tightly. The color of this decayed mass in the earlier stages before drying down is a light brown. The dead brood may be either capped or uncapped and the cappings are often sunken and perforated. The odor in American Foul Brood is usually marked and perhaps more noticeable after the mass has dried down to form the scale. This odor is not always unpleasant. It has been likened to that of a glue pot, which perhaps is as descriptive a comparison as can be made. This disease rarely attacks drone larvæ.

In European Foul Brood there is not the tendency toward ropiness, as in American Foul Brood, although a slight degree of ropiness does sometimes occur. The scale that forms in this disease does not adhere as a rule very closely to the cell wall and is more usually found at the base of the cell. These scales often show lines running around the dead grub, marking it off into divisions. The color of the scales is a yellowish brown or gray, sometimes quite dark brown. In the earlier stages before drying down the larva is of a yellowish or gray color and has what might be called a "melting" appearance, by which it is understood that the larva becomes a moist collapsed mass. The brood in this disease is not so often capped as it is in American Foul Brood, since it is the younger larva that are more often attacked. The disease attacks queen and drone larvæ as well as worker brood.

The adult bees of a colony affected with either of these diseases do not seem to work with their usual activity, and the bee keeper will probably note a general listlessness about the hive. Owing to the large amount of brood dying, the colony constantly dwindles in strength, often becoming so weak that robbers enter and spread the infection to other hives in the apiary.

In these two diseases there is great variation, so that it is not a simple matter to give a general description applicable in every detail to all cases. Variation occurs in both of these diseases, and they may become so much alike in appearance that in some cases the distinguishing of the one from the other requires considerable care. In case there is any doubt in the mind of the bee keeper about diagnosis the Bureau of Entomology, United States Department of Agriculture, Washington, D. C., is always willing to aid the bee keeper by examining samples of brood suspected of being diseased. Neither of these diseases can be diagnosed from empty comb, honey, or dead adult bees. Hence, in suspected cases larvæ of the age at which the disease has been described as attacking the brood should be sent. A piece of comb four or five inches square is sufficient.

If a honey flow is on so that there is no danger from the spread of the infection by robbing, the diseased colony or colonies should be at once by shaking. This is done in the following manner: Prepare a clean hive containing new frames with strips of foundation about ¼ inch wide. Set this hive on the old stand, having previously moved the old hive away a foot or two to one side so that it is within easy reach. If the bees are to be shaken directly into the new hive from the top, some of the central frames with starters should be taken out to make a clear space into which the old frames covered with bees can be lowered. Each frame from the old hive is to be taken out separately, lowered into the new hive as above stated and given several vigorous up and down shakes to dislodge all of the bees. A third empty hive body should be near at hand to receive the old frames as fast as the bees have been dislodged. Both the old hive from which frames with bees are being taken, and the third hive body into which they are placed after shaking should be provided with close fitting covers and bottoms, and closed entrances so that no robber bees may enter to carry away infected material. After all the bees are shaken into the new hive, put in the remaining new frames previously removed to make space for shaking. Close the hive and put a queen trap at the entrance to prevent the colony from swarming out. Bees on being shaken into a hive provided only with starters without comb, eggs or brood sometimes leave. The excluder is intended to prevent this. Alley's queen and drone trap (Fig. 20) is suitable for this purpose. The bees are not to be given any food for 48 hours and not even then if honey is coming in from the field.

There is nearly always a little unsealed honey in the combs, a part of which will be shaken out into the hive. This can be left, as it is concealed from would-be-robbers when the hive is closed at the end of the shaking. A slight modification may be suggested here. If the honey flow is heavy so that a large amount of honey is shaken out it is better to shake the bees at the entrance on a run-way board inclined at a gentle slope. This may be covered with paper and the soiled paper destroyed later.

If there is considerable brood in the old infected combs it can be saved by placing the frames over a weak diseased colony. This allows the young bees which emerge to go below, thus strengthening the colony, which later is treated also, as just described. In case it is not desirable to save the brood, all of the old infected combs can be carried to the honey house and rendered into wax as soon as possible. This can be done by thoroughly boiling in hot water. To secure all of the wax the slumgum or debris remaining after boiling should afterwards be run through a wax press.

It is rarely advisable to try to save the honey yet if this is desired it should first be extracted. Honey thus obtained from old infected combs must be diluted with about an equal amount of water, and boiled in a closed vessel directly over the flame for one hour. Heating in one receptacle set inside of another containing boiling water is not safe as the spores will not be killed. It will be readily understood that this honey can be used for no other purpose than feeding back to the bees at some future time, as it is almost certain to be somewhat scorched. It should never be used for winter stores.

The old frames should be burned as they are not worth saving. Old hive bodies should be scorched until the wood is slightly charred. A painter's torch can be used to good advantage for this purpose, and in case this is not available a little gasoline may be poured in on straw and ignited. Caution must be exercised in using such inflammable material.

As before said, the shaking treatment is to be recommended only when a honey flow is on, in order to prevent robbers carrying the infection to other hives in the apiary. If there is a dearth of nectar, it is better to wait for a flow unless the colony is too weak to make this safe. The entrance of all infected and weak colonies should be contracted to reduce chance of robbers entering. If there is no prospect of another honey flow, then a tent made of mosquito netting supported on a light wooden frame can be used. This should be large enough to permit the easy movement of the operator in manipulating.

Another disease attacking the brood late in the larval stage is the so-called "pickle brood." The cause of this disease is not known. It usually disappears of its own accord and no treatment is recommended.

Dysentery has been mentioned in another part of this bulletin.

"Paralysis" is a malady in which the bees are described as being seized with a peculiar trembling. No treatment can be recommended.

INSECT ENEMIES.

Of the other enemies which attack bees the two wax moths are the most important. There are two species of these, the large wax moth (*Galleria mellonella L.*) and the lesser wax moth (*Achroia grisella Fab.*). The larvæ of these moths hatch from eggs that have been deposited on the combs and on bits of wax about the hive. They do much damage even destroying completely whole frames of comb. No trouble will be experienced if the colonies are kept strong with bees.

To destroy the larvæ of the wax moth in combs outside of the hive, tier the bodies and place a quantity of carbon bisulphid in a saucer in an empty super placed at the top of the tier. The gas is heavier than the air and sinks down through all of the hive bodies. Care should be used not to bring a flame near the tiers of hives as the gas is highly inflammable.

MISCELLANEOUS INFORMATION.

Hive Records.

The bee keeper should keep a record to be preserved in permanent form of each and every colony in the apiary. The hives should be numbered and entries made in book or card form for each hive. By referring to this written record from time to time, the manipulation of the colonies can be undertaken with more certainty of intelligent action. This is particularly applicable to an apiary of considerable size.

Thus by making note of the time when honey begins to be stored in the supers, and later of the time of cessation of the flow, an idea can be attained of the length of the honey flows, which as before mentioned is particularly important for the producer of comb honey. Records will also be desired of the date of introduction of new queens, and of their activity after being introduced, and of many other items of information too numerous to mention.

The numbering device should be detachable so that it can be easily put in place and as easily removed. This will be appreciated when it is remembered that the old hive body will often be removed and a new hive body bearing the old number put in its place on the old stand, as in swarming and numerous other manipulations.

Numbering devices can be of wood or metal. Pieces of section with black figures stenciled against a white background are a cheap and satisfactory device. These can be slid in and out between three staples as shown on previous cuts in this bulletin. Some arrangement whereby the numbering tag would be flush with the hive body instead of projecting as the piece of section mentioned, would be an improvement. Circular metal tags, countersunk by means of an auger, would fulfill this requirement.

LITERATURE ON BEE KEEPING.

Books and Journals. The bee keeper will find at least one good journal and one or more books relating to apiculture to be indispensable. Of the journals, Gleanings in Bee Culture, published at Medina, Ohio; The American Bee Journal, published at Chicago, Illinois, and the Bee Keepers' Review, published at Flint, Michigan, are the three publications issued in this country.

Of the books on bee keeping there are many from which to select. The following will be found valuable:

ABC and XYZ of Bee Culture, A. I. Root, Co., Medina, Ohio.

Langstroth on the Hive and Honey Bee, C. P. Dadant, Hamilton, Ill.

Manual of the Apiary, A. J. Cook, Claremont, California.

Dr. Miller's Forty Years Among the Bees, Geo. W. York, 117 N. Jefferson St., Chicago, Ill.

Avanced Bee Culture, W. Z. Hutchinson, Flint, Michigan.

The literature should include catalogues of manufacturers of hives, and other bee supplies. These will be found to contain much valuable information.

Government Publications. There are several publications of the Departmentof Agriculture which are of interest to bee keepers and new ones are added from time to time in regard to the different lines of investigation.

The following publications relating to bee culture, are for free distribution and may be obtained by addressing the Secretary of Agriculture, Washington, D. C.

This list is taken from Farmers' Bulletin 447.

BUREAU OF ENTOMOLOGY.

Farmers' Bulletin No. 447, "Bees." By E. F. Phillips, Ph. D. 1911. 48 pp., 25 figs.

A general account of the management of bees.

Farmers' Bulletin No. 442, "The Treatment of Bee Diseases." By E. F. Phillips, Ph. D. 1911. 22 pp., 7 figs.

This publication gives briefly the symptoms of the various bee diseases, with directions for treatment.

Circular No. 94, "The Cause of American Foul Brood." By G. F. White, Ph. D. 1907. 4 pp.

This publication contains a brief account of the investigations which demonstrated for the first time the cause of one of the brood diseases of bees, American foul brood.

Circular No. 138. "The Occurrence of Bee Diseases in the United States. (Preliminary Report.)" By E. F. Phillips, Ph. D. 1911. 25 pp.

A record of the localities from which samples of diseased brood were received prior to March 1, 1911.

Bulletin No. 55, "The Rearing of Queen Bees." by E. F. Phillips, Ph. D. 1905. 32 pp., 17 figs.

A general account of the methods used in queen rearing. Several methods are given, so that the bee keeper may choose those best suited to his individual needs.

Bulletin No. 70, "Report of the Meeting of Inspectors of Apiaries, San Antonio, Tex., November 12, 1906." 1907. 79 pp., 1 plate.

Contains a brief history of bee-disease investigations, an account of the relationship of bacteria to bee diseases, and a discussion of treatment by various inspectors of apiaries and other practical bee keepers who are familiar with diseases of bees.

Bulletin No. 75, Part I, "Production and Care of Extracted Honey." By E. F. Phillips, Ph. D. "Methods of Honey Testing for Bee Keepers." By C. A. Browne, Ph. D. 1907. 18 pp.

The methods of producing extracted honey, with special reference to the care of honey after it is taken from the bees, so that its value may not be decreased by improper handling. The second portion of the publication gives some simple tests for adulteration.

Bulletin No. 75, Part II, "Wax Moths and American Foul Brood." By E. F. Phillips, Ph. D. 1907. Pp. 19-22, 3 plates.

An account of the behavior of the two species of wax moths on combs containing American foul brood, showing that moths do not destroy the disease-carrying scales.

Bulletin No. 75, Part III, "Bee Diseases in Massachusetts." By Burton N. Gates. 1908. Pp. 23-32, map.

An account of the distribution of the brood diseases of bees in the State, with brief directions for controlling them.

Bulletin No. 75, Part IV, "The Relation of the Etiology (Cause) of Bee Diseases to the Treatment." By G. F. White, Ph. D. 1908. Pp. 33-42.

The necessity for a knowledge of the cause of bee diseases before rational treatment is possible is pointd out. The present state of knowledge of the causes of disease is summarized.

Bulletin No. 75, Part V, "A Brief Survey of Hawaiian Bee Keeping." By E. F. Phillips, Ph. D. 1909. Pp. 43-58, 6 plates.

An account of the beekeeping methods used in a tropical country and a comparison with mainland conditions. Some new manipulations are recommended.

Bulletin No. 75 Part VI, "The Status of Apiculture in the United States." By E. F. Phillips, Ph. D. 1909. Pp. 59-80.

A survey of present-day beekeeping in the United States, with suggestions as to the work yet to be done before apiculture will have reached its fullest development.

Bulletin No. 75, Part VII. "Bee Keeping in Massachusetts." By Burton N. Gates. 1909. Pp. 81-109, 2 figs.

An account of a detailed study of the apicultural conditions in Massachusetts. The object of this paper is to point out the actual conditions and needs of beekeeping in New England.

Bulletin No. 75, Contents and Index. 1911. Pp. VIII+111-123.

Bulletin No. 75, Parts I-VII, complete with Contents and Index. 1911. Pp. VIII+123.

Bulletin No. 98, "Historical Notes on the Causes of Bee Diseases." By E. F. Phillips, Ph. D., and G. F. White, Ph. D., M. D. (In press.)

A summary of the various investigations concerning the etiology (cause) of bee diseases.

Technical Series, No. 14, "The Bacteria of the Apiary, with Special Reference to Bee Diseases." By G. F. White, Ph. D. 1906. 50 pp.

A study of the bacteria present in both the healthy and the diseased colony, with special reference to the diseases of bees.

Technical Series No. 18, "The Anatomy of the Honey Bee." By R. E. Snodgrass. 1910. 162 pp., 57 figs.

An account of the structure of the bee, with technical terms omitted so far as possible. Practically all of the illustrations are new, and the various parts are interpreted according to the best usage in comparative anatomy of insects. A brief discussion of the physiology of the various organs is included.

BUREAU OF CHEMISTRY.

Bulletin No. 110, "Chemical Analysis and Composition of American Honeys." By C. A. Browne. Including "A Microscopical Study of Honey Pollen." By W. J. Young. 1908. 93 pp., 1 fig., 6 plates.

A comprehensive study of the chemical composition of American honeys. This publication is technical in nature and will perhaps be little used by practical bee keepers, but it is an important contribution to apicultural literature. By means of this work the detection of honey adulteration is much aided.

HAWAII AGRICULTURAL EXPERIMENTAL STATION, HONOLULU, HAWAII.

Bulletin No. 17, "Hawaiian Honeys." By D. L. Van Dine and Alice R. Thompson. 1908. 21 pp., 1 plate.

A study of the source and composition of the honeys of Hawaii. The peculiar conditions found on these islands are dealt with.

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